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AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

DECEMBER 1931

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Coordination of Research on Flow of Water in Soils - - - - - - *O. W. Israelsen*

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VOL. 12 NO. 12

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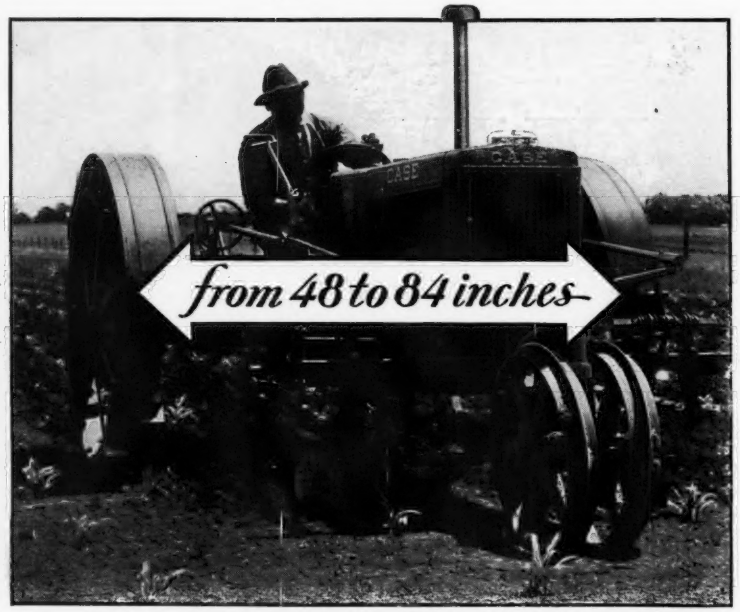

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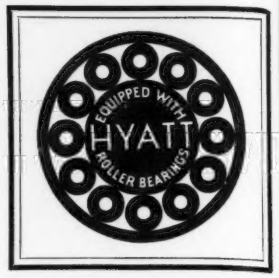

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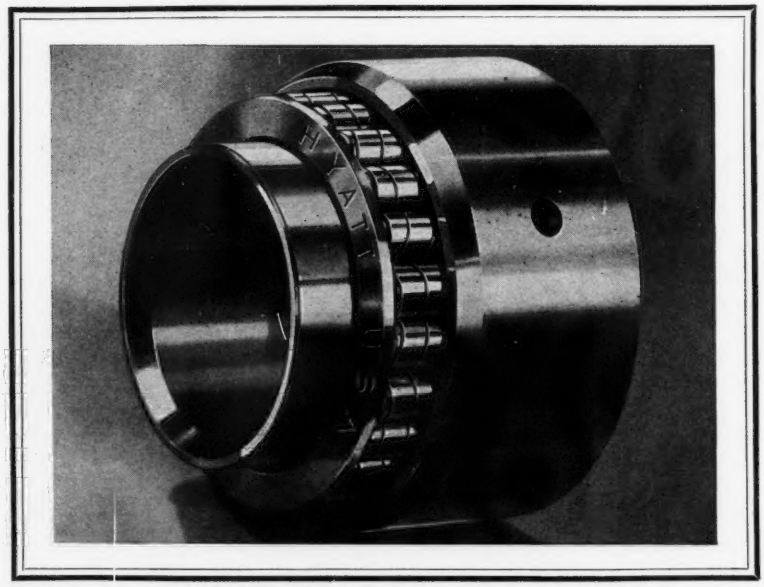

HYATT
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AGRICULTURAL ENGINEERING

Volume 12 DECEMBER, 1931 Number 12

New Developments in Machinery for Processing Animal Feeds[1]

By F. J. Bullock[2] and F. H. Hamlin[3]

TO THE casual observer the past year has brought forth no startling developments in feed-processing machinery. Developments, however, there have been, and when we consider the fact that nearly 70 per cent of all crop acreage is devoted to feeding livestock, according to the U. S. Department of Agriculture, it is apparent that any development affecting the utilization of feed crops may well be of far-reaching importance.

In the past so much emphasis has been placed on feed processing as a means of increasing digestibility that we sometimes lose sight of another function fully as important, namely, more efficient storage and more convenient handling. Thousands of acres of corn will be fed this winter as ground fodder instead of silage, not because it is a better feed, but simply as a matter of convenience.

Without exception feeding trials show that in terms of meat or milk production an acre of silage is worth twice as much as an acre of ground fodder. But silage making involves special storage and special machinery. More important, it requires a lot of hard work concentrated at a time when there are many other demands on the farmer's time. Fodder, on the other hand, can be ground as fed during the slack winter months. In the meantime, all outdoors supplies the storage. The cash outlay required for a good combination grain and roughage grinder is very much less than for a silo and an ensilage cutter.

Improvements in ensilage cutter design during recent years have done something to reduce the cost and inconvenience of silo filling. The general adoption of roomier feed tables and auxiliary beater rolls have made direct-from-the-wagon feeding practical, thus eliminating all labor at the cutter. Numerous minor refinements have made silo filling feasible with single-phase electric power which allows the work to be done over a longer period, without extra help and without so much interference with regular farm work.

More rapid advance has probably been made in grinder design, especially in hammer-type mills which are comparatively new and which consequently offer more opportunity for development. The addition of feed rolls, although of primary importance in handling roughages, improves the efficiency of grain grinding by providing even distribution of grain to the hammers. Governors to control rate of feed prevent clogging, protect power against overload, and at the same time insure maximum use of available power. Blower and air separator equipment make for convenient and practically dustless delivery to bag or bin.

While these developments have an important bearing on the utilization of small grains, corn and the grain sorghums, they affect but little 73 million acres of hay. This crop, which accounts for one-third of the entire feed acreage and one-fifth of all crop land, has not been given the attention it deserves.

It is common knowledge that in ordinary farm practice a very appreciable portion of the hay crop is wasted. Stock nose over the hay, eat the tender parts and trample the coarser stems under foot. Extensive work on the comparative value of chopped and whole alfalfa for feeding steers has been done by Rinehart and Johnson at the Idaho agricultural experiment station. Each year since 1919 from two to five carloads of steers have been fed experimentally, part on chopped hay and part on long hay or in combination with grain and silage. The data for all cattle fed up to 1924 shows that chopping saved 16 per cent on hay, 18 per cent on silage and 9 per cent on grain required for a 100-pound gain. A summary of the results follows:

	Whole Hay	Chopped Hay
Average daily gain	1.51 lb	1.63 lb
Average hay fed per 100-lb gain	2038 lb	1759 lb
Average silage fed per 100-lb gain	1022 lb	869 lb
Average grain fed per 100-lb gain	351 lb	321 lb

The tests conducted during 1927 showed that the steers receiving cut hay gained ½ pound per day more than those on whole hay. Moreover, 150 pounds less hay was required to put on each 100 pounds gain. Feed cost per 100-pound gain was thereby reduced $1.40.

Likewise the most recent Idaho report shows a marked advantage on the side of chopped hay. Steers gained ¼ pound more per day on it with about 300 pounds less hay. A careful check showed that 10.3 per cent of all whole hay fed was wasted.

	Whole Hay	Chopped Hay
Average daily gain	1.36 lb	1.82 lb
Average daily ration	23.45 lb	25.05 lb
Percentage of hay wasted	10.3	4.6
Average daily hay consumed	21.04 lb	22.01 lb
Hay required per 100-lb gain	1613 lb	1339 lb

In this connection Rinehart points out that the hay was fed rather sparingly and that a higher percentage of waste might be expected with average farm feeding. Lambs at the same station wasted 23 per cent of their hay during

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at New Brunswick, New Jersey, October 1931.

[2]Vice-president and chief engineer, Papec Machine Company. Mem. A.S.A.E.

[3]Advertising manager, Papec Machine Company.

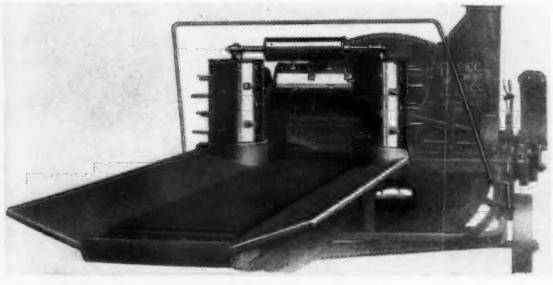

Fig. 1. Detail of three-roll hay-feeding mechanism of the 19-inch machine. A load weighing well over a ton was put through this chopper by three men in five minutes during a trial run

the 1928 trials. Rupel and associates at Wisconsin found that, in feeding soybean hay of ordinary quality to dairy cows, 18 per cent was refused and, in another test, 20 per cent[4].

These and other trials also show beyond all reasonable doubt that feeding waste can be almost entirely eliminated by processing[5]. Moreover, it has been established that the net energy value of hay is essentially the same when coarsely cut as when ground into a fine meal[6].

Superficially it would seem that, if a 20 per cent waste can be eliminated by chopping $20 hay, any processing at less than $4 per ton would be profitable. Actually, the 20 per cent waste consists of the least valuable part of the crop. Hence, the working margin is much narrower. That some practical margin does exist, however, is shown by the following analysis of alfalfa stems: Ash, 8.71 per cent; protein, 11.14 per cent; nitrogen-free extract, 41.04 per cent; fat 1.82 per cent[7].

The opportunity for profitable processing is again affected by the quality of the hay. Not over one or two per cent of good second cutting alfalfa, when not overfed, will be rejected. Poorly-cured first cutting will sometimes show a 35 per cent wastage.

From this it might be assumed that the general use of machinery for processing hay crops is dependent on whether or not the cost of processing will generally exceed the value of the feed saved. We would take issue with this conclusion on two grounds: (1) Because it is assumed that the only economic justification for processing hay is the elimination of feeding waste, and (2) because it is indirectly assumed that processed hay must necessarily cost more to feed than unprocessed hay.

If it were possible for the ordinary farmer to harvest his field-cured hay, store it in chopped form, and feed it at no more handling cost per ton than for bulk hay, there would be a number of very definite advantages entirely aside from any saving in feed. This not only can be done, but is being done and done as a direct result of a recent development in feed-processing machinery.

The machine involved is essentially a heavily-built, blower-type ensilage cutter with a specialized self-feeder. Close-set steel angles convey the hay to one or more finger feed drums. (Figs. 1 and 2.) These fingers, working in self-oiling bushings, extend to their full length, draw in the loose hay, and then recede into their drums to release the compressed mass as it reaches the inner, toothed feed rolls. The inner rolls hold the hay under increased compression while the knives do their work.

If we discount entirely the machine's possibilities as a saver of feed, its economic justification must stand or fall on the degree of efficiency with which it handles the crop as compared with existing methods. The cheapest and most efficient way of putting bulk hay into the mow requires from two to four men and a boy — one man to handle the hay fork and trip rope, the boy to drive the team which raises the load, and one or more men inside the barn to mow the hay away. The average load is put up in three or four lifts, requiring about 15 to 20 minutes for the load. The time can be cut to about 10 minutes by using two double harpoon forks for two lifts and slings on the bottom for the final lift, but this system usually requires more labor in the mow.

Now compare this with the chopping method. The hay is mowed, raked, cured, loaded, and hauled to the barn exactly as usual. Two good men on the wagon and one at the chopper can roll off a load in 6 or 7 minutes. One man and a boy after a little experience in feeding the machine will put through a load in about 15 minutes. The hay is blown into the mow. The air blast will carry the hay 35 to 40 feet after it leaves the pipe. Except for the occasional redirection of a goose-neck on the end of the pipe, no labor whatever is required inside the hot, dusty barn.

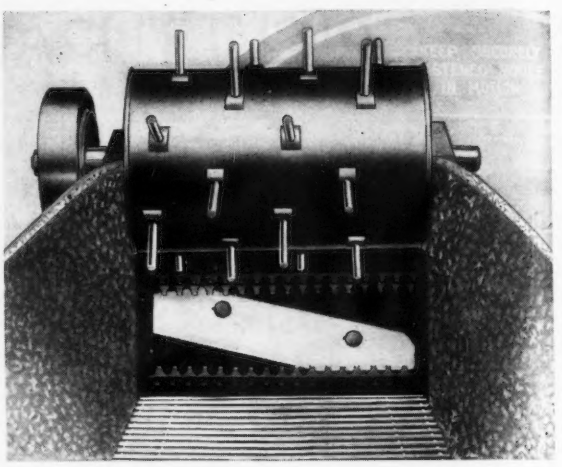

Fig. 2. Detail of single-roll hay-feeding mechanism of the 15-inch chopper. Best capacity noted to date for this size is a load in seven minutes with three men feeding

The savings in man and horse hours of work usually more than offset the cost of power to run the chopper. Equipment overhead is not so much of an item as it would first appear. On most stock farms where any appreciable amount of hay is grown, silage is also fed. The chopper, without any change-over whatever, makes the most efficient type of silo filler obtainable. Its yearly hours of service are further lengthened by its ability to shred fodder, elevate feed grain and cut straw as it comes from the thresher. On farms where 75 to 100 tons of hay are fed annually, the cost of handling the crop by chopper will usually run almost exactly the same as for the fork-and-carrier method. Smaller operators whose yearly use of equipment is more limited, will find the cost of chopping 50 cents to a dollar per ton higher than putting their hay up in bulk. On the other hand, a number of 200 to 400-ton crop farms, where costs could be figured with reasonable accuracy last year, showed actual savings of 50 cents to a dollar a ton by the chopper method (Fig. 4).

Cost of Putting Hay in Storage by Fork and Carrier Method

Basic Data for Finding Costs—	
Amount of hay handled per year	100 tons
Installed cost of track, carrier, fork, rope, etc.	$80
Life of equipment	36 years
Rate of operation	4 tons per hour
Size of crew	4 men
Power required	1 team
Cost of handling 100 tons per year—	
Depreciation on equipment (1/36 of initial cost)	$2.22
Interest (6 per cent of depreciated investment)	2.47
Repairs (2 per cent of initial cost)	1.50
Labor (100 man-hours at 40 cents)	40.00
Power (50 horse-hours at 18 cents)[8]	9.00
Total cost for handling 100 tons	$55.29
Average cost per ton	55 cents

Cost of Putting Hay in Storage by Chopper Method

Basic Data for Finding Costs—	
Amount of hay handled per year	100 tons
Cost of chopper	$365.00
Life of chopper	12 years
Time in operation per year (all work)	60 hours[9]
Rate of chopping	5 tons per hour

[4]Bohstedt, G., and associates, Wis. Exp. Sta. Res. Bul. 102, Dec. 1930.

[5]Nevens, W. B., Ill. Exp. Sta. Ann. Report 1925-26; Potter, E. L., and Withycombe, R.; Ore. Exp. Sta. Bul. 174.

[6]Journal of Agricultural Research 31, 1925.

[7]Neb. Exp. Sta. Res. Bul. 36.

[8]Based on Cornell study use of horses on New York State farms.

[9]Chopping hay, 20 hours; filling silo, 20 hours; cutting straw, 10 hours; shredding fodder, 5 hours; elevating grain, 5 hours.

Size of crew	2 men
Power required	2-plow tractor
Cost of handling 100 tons per year—	
Depreciation chargeable to hay chopping (1/36 of initial cost)	$10.14
Interest (6 per cent of ⅓ total depreciated investment)	3.75
Repairs (2 per cent of initial investment)	7.30
Labor (40 man-hours at 40 cents)	16.00
Power (20 tractor-hours at 84 cents)	16.80
Total cost of handling 100 tons	$53.99
Average cost per ton	54 cents

When reasonable allowances for equipment depreciation, interest and repairs are added to the labor and power costs for handling one hundred tons per year under typical farm conditions, we arrive at the total cost figure of 55 cents per ton for the fork-and-carrier method as compared with 54 cents for the chopper method. In so doing, labor was arbitrarily charged at 40 cents per hour. If, instead, it were charged at 30 cents, then there would be a 5-cent per ton advantage in favor of the fork method. By the same token, tractor power was figured at 84 cents per hour, which is the charge ordinarily made by Pennsylvania State College for two-plow tractor operation in the field. Mr. R. U. Blasingame, head of the agricultural engineering department at that institution, says that 60 cents per hour would be an acceptable figure for belt work of this type. When the 60-cent figure is used, the chopping method shows a 7-cent per ton advantage instead of a 1-cent advantage over the fork method.

For the purposes of this discussion, then, we may assume that the cost of putting 100 tons of chopped hay in the mow is the same as for 100 tons of bulk hay. That being the case and barring from consideration the possibility of increased feeding value, chopping as a mechanical means of putting hay in storage has no more than broken even with the conventional method. The cost of handling the crop, however, does not stop when the hay reaches the mow. The expense of housing the hay, getting it out of storage, feeding it and disposing of rejected portions is yet to be considered.

After whole hay has been put up by loader and harpoon, the biggest part of the handling cost is still ahead. Once settled, it is a man-sized job to remove the tangled hay. Of chopped hay, a dairyman recently wrote, "My 9-year old boy throws down all the hay for 26 head. He also does the feeding." Then lest we think him a slip-shod feeder, our correspondent adds in parenthesis, "Under supervision, of course."

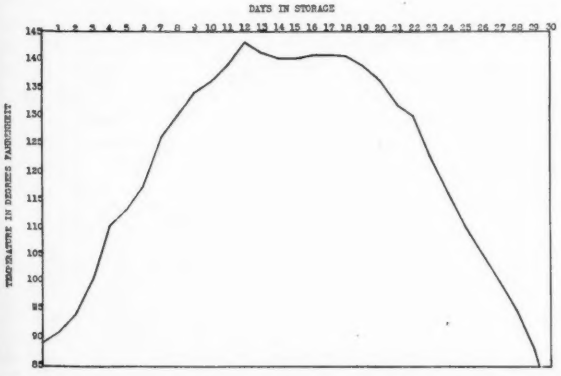

Fig. 3. These temperature readings were taken once each 24 hours in a mow of first cutting alfalfa hay measuring 7 feet high, 21 feet wide and 40 feet long, and containing 63 tons, weighed as taken from the field. Two nitrogen-filled thermometers were used. One was placed in the center of the mow 30 inches from the top and was removed only for its daily reading. The other was used as a check to feel for a hotter spot elsewhere in the hay. None was found during the thirty days

Enough long pieces go through the chopper to act as a binder for a good-sized forkful, yet the hay is fine enough to be readily mixed with concentrates or with other hay cuttings. Gutters and mangers do not fill up with rejected hay. Manure is much easier to handle in the spreader, especially if bedding straw is also chopped.

Strangely enough, a number of farmers have commented on the fact that chopped hay seems to be less dusty to feed. This may be explained by the separation of dust from the hay as it is blown in. One report describes chopping 20 tons of bone-dry hay which was almost black from many wettings and long lying in the field. The hay was blown on to an open barn floor. After the fog had settled, over a ton of white dust was scooped up from around the pile and hauled away. The hay itself had brightened up considerably and was being cleaned up well by dry stock.

These advantages are, of course, more a matter of convenience than of definitely decreased costs. The chopper method offers more tangible savings when it comes to the comparison of housing costs. Bulk hay requires 340 to 580 cubic feet of storage space per ton[10]; chopped hay only 100 to 290 cubic feet per ton[11], depending on depth, time in and kind of hay. A few hours after being put in, chopped hay is ordinarily more dense than baled hay. This immediately suggests two possibilities of savings. First, the farmer who has been forced to stack part of his crop outside, thereby suffering considerable loss from weathering, can now get twice to three times as much of his hay under cover, assuming of course that his barn will carry the additional weight. Second, the farmer who is building or remodeling need provide less than half the usual space for hay storage, thereby cutting construction costs very appreciably.

A specific example is found in the case of the Kendall Stock Farm near Indianapolis, Indiana, where chopping saved an expenditure of $1800 for raising the barn roof to take care of an increase in hay acreage. In the case of new construction, it seems probable that upwards of $2,000 can be saved by building a one-story, fireproof stable with an adjacent structure for chopped hay storage.

The removal of the menace of spontaneous combustion from the same building which houses livestock has obvious advantages. Moreover, the density of chopped hay in storage retards the free circulation of air, thus cutting off oxygen supply which is necessary for actual spontaneous ignition. While it may be possible for poorly cured, chopped hay to ignite spontaneously, the authors have never been able to run down a clear-cut case. On removal of poorly-cured chopped hay months after it had gone in, we have, however, discovered pockets which had apparently burned themselves out for lack of oxygen.

In other words, it seems reasonable to assume that chopped hay should be a poorer subject for spontaneous ignition than bulk hay. This is further borne out by comparative temperature readings which indicate that bulk hay reaches a higher peak heat than chopped hay stored under the same conditions, although the peak heat is less general throughout the mow and is not retained so long.

The questions of mold and bacterial activity, color retention and aroma are closely bound up with the heating of hay in storage[12], but they affect this discussion only in so far as the curing process in the field is affected by chopping. It is claimed by a growing number of experienced operators that hay can safely be put into the barn with less curing when chopped than when long. While such a practice, until definitely proved otherwise, must be considered as a very literal form of playing with fire, it is true that the chopping and blowing process subjects the hay to a thorough aeration and mixes the poorly cured portions with the well-cured. This fact coupled with the density of chopped hay lends some credence to the idea.

The whole problem of curing hay has assumed new importance with the rapidly increasing acreage in alfalfa and

[10]Henry & Morrison's "Feeds & Feeding."

[11]Based on studies made by the authors.

[12]Browne, C. A., U. S. Dept. of Agr. Tech. Bul. 141, Sept. 1929.

clover. Protracted field curing of these hays means heavy loss of the leaves which carry up to 70 per cent of the plant's protein[13]. Any assistance, however slight, the chopping method can give the curing process will be a very real factor in its favor.

Chopping would likewise seem to offer an increased safety factor in making "brown hay." This practice, though frowned upon by European investigators because of the attendant shrinkage in dry-matter weight, is gaining favor with many practical dairymen in this country. J. J. Anderson, manager of a 230-cow herd at Avon, Connecticut, has stored annually since 1916 several hundred tons of whole legume hay, containing 35 to 40 per cent moisture, or nearly double the moisture content ordinarily considered safe. No fire or burned-out fire pockets have resulted. The highest temperature observed during the period was 165 degrees F. A heavy sweat leaves a "tobacco-brown" hay of high analysis and excellent aroma which, pound for pound, is apparently a better milk producer than bright, green hay. It is Anderson's opinion that, if the theoretical shrinkage of 20 to 30 per cent in dry-matter weight actually does exist, the loss is more than offset by leaf retention made possible through reduced curing hours.

This year he cured his hay exactly as usual but stored it by chopper, primarily as a means of saving 400 man-hours of labor cost. The hay was mowed in the three-fourths-bloom stage after the dew was off, allowed to lie in the swath until wilted, raked into small continuous windrows, then doubled up with the side-delivery rake, and finally hauled to the chopper from 26 to 30 hours after mowing[14]. Although the moisture content of the hay when put in was undoubtedly as high as in former years, the maximum temperature reached on the twelfth day of storage was only 143 degrees, or 22 degrees lower than the maximum for bulk hay. (Fig. 3) The following data shows how slowly the original moisture content of over 35 per cent was reduced in storage:

Kind of hay	Days in Storage	Per Cent Moisture Content[15]
Alfalfa and clover	20	29.76
Alfalfa and alsike	30	27.09
Alfalfa	60	21.79

The very general opinion among users of "brown hay," that it is a better producer than brighter hay, is supported by the findings of certain European investigators, and by the following comparison of analyses, all first cuttings being on an absolute dry basis:

	Average of 46 analyses[16]	Colorado alfalfa[16]	Dehydrated alfalfa[17]	Chopped, brown alfalfa[15]
Ash	9.62	11.29	9.67	10.12
Ce. protein	15.19	16.80	20.99	22.35
Fiber	33.77	37.28	23.37	23.87
N-free ext.	39.56	33.23	42.85	39.69
Fat	1.86	1.40	3.12	3.97

A sample of Anderson's chopped, brown hay analyzed 22 per cent crude protein, nearly 4 per cent fat and only 24 per cent fiber. While it is known that a mild fermentation in hay will cause a breaking down of fiber into more digestible forms, it is hard to believe that this process can produce a feed approaching the value of the artificially dehydrated product as is indicated by their comparative analyses.

This question offers a fertile field for experiment station investigation as does the whole question of chopped hay storage and feeding. The brunt of the work has, to date, been carried on the shoulders of private resource, just as it has been in the case of forage dehydration and other developments in feed processing which bid fair to revolutionize standard farm practice, if not agriculture itself.

Fig. 4. This machine at Laurel Locks Farm, Pottstown, Pa., averaged 8 to 10 tons per hour for 150 tons with two men feeding. The net saving in handling cost was estimated at $75. The pipe arrangement shown here is not ideal. When operating speed drops under peak load conditions there is a tendency for hay to drop to the bottom of the pipe and start sliding down, the air blast escaping over it. Pipe clogging may result

In the meantime, the chopping of conventionally cured hay offers immediate advantages for thousands of practical farmers. Several hundred of them, scattered from coast to coast, have already had one or more years' experience with the chopper method. By way of summary and conclusion we can do no better than present the following very typical letter recently received from one of these "dirt" farmers:

"This year and last we put up about 120 tons of mixed hay with our chopper. Using two less men than formerly, we got several extra loads in each half day. Enough mow space was saved so we could put our bedding straw under cover. This was chopped just as it came from the wind-stacker. There wasn't a man in the barn a moment while the machine was in operation. This also applies to the hay chopping, and is a big advantage in keeping the men out of the hot, dusty mow. We also use our machine to deliver grain to the bins after threshing, and to fill silos. All costs figured in, I should say we save right close to $50 a year in the cost of handling our hay alone. The feeding value of chopped hay is undoubtedly ahead of loose hay. I have no figures to show just how much. I would sum up the advantages of chopping hay according to our experience as follows: Faster handling with less men; less storage space required; easier to get from storage; less dust in feeding; less feeding waste; easier to handle the manure."

Value of Research

RESEARCH grew out of man's attempt to satisfy his curiosity concerning nature. Now, however, it is more frequently undertaken to satisfy the needs of the engineer — to provide, through scientific methods and systematic search, information required in the design of products, equipment and plants.

The function of the engineer is to combine known facts with "scientific" guesses based on experience. As the results of more and more research become available and the known facts increase, the work of the engineer becomes less a matter of guess and judgment.—Power

[13]Klesselbach, T. A., and Anderson, A., U. S. Dept. of Agr. Tech. Bul. 235, April 1931.

[14]Duffee, F. W., C.R.E.A. News Letter No. 11, April 1931, p. 4, Fig. 1.

[15]Analyses by Conn. Exp. Sta. at Storrs.

[16]Headden, W. P., Colo. Exp. Sta. Bul. 110, April 1906.

[17]Kiefer, H. E., "Feedstuffs," July 12, 1930, p. 12.

Coordination of Research Concerning the Flow of Water in Soils[1]

By O. W. Israelsen[2]

ADVANCEMENT in our ability to compute the quantity of water that will flow in unit time through a given area of soil under specified conditions is likely to be accelerated by coordination of research concerning the flow of water in soils. The importance of such research is attested by the large amount of attention that has been given to it. In irrigated regions, reliable information concerning the flow of water in soils is especially valuable.

In the study of industrial problems related to the flow of water in soils, engineers have commonly considered only the flow in soils that are completely saturated with water; whereas, in the study of irrigation and drainage problems, it is frequently essential to investigate also the flow in unsaturated soils, i.e., capillary flow. The study of capillary water flow in recent years has probably been given more attention by physicists than by engineers, although irrigation and drainage engineers are deeply interested in the capillary flow of water in soils. In order to coordinate research concerning the flow of water in soils, it would seem desirable that engineers and physicists, whether working with saturated or unsaturated soils, agree upon the application of certain basic guiding principles in so far as present knowledge of the problem will justify. Furthermore, coordination of effort necessitates also clear understanding by all research workers of terms, symbols, and constants used by both engineers and by physicists.

In this paper an attempt is made to describe in the language commonly used by engineers the "potential function" that the physicists use, and to show the relationship of the "gradient of the potential" as used by physicists to the "slope of the hydraulic grade line" as used by engineers. Attention is given also to the derivation and definition of a water-conductivity factor, which in recent years has been variously designated as "transmission constant," "capillary conductivity," "transmission coefficient," and "specific water conductivity." It is suggested that this conductivity factor be represented by the symbol, k, and that it be designated "specific water conductivity."

To simplify the analyses, this paper is restricted to a consideration of one-dimensional steady flow, i.e., rectilinear flow wherein the same quantity of water flows past a series of points along the channel.

Before considering in particular the flow of water in soils some of the general aspects of the flow of water are briefly outlined. For steady rectilinear flow the following conditions are assumed to obtain:

1. That for extremely low velocities, such as commonly occur in soils, both saturated and unsaturated, stream line flow occurs and the frictional force per unit of water is therefore proportional to the first power of the velocity.
2. That the velocity is proportional to the potential gradient, i.e., that Darcy's law applies[3].
3. That the driving force per unit mass (F_d) that causes flow is equal in magnitude and opposite in direction to the frictional force per unit mass F_r that retards flow, a condition essential to uniform flow.

Hydraulic and Energy Grade Lines. For steady flow of constant-density fluids (such as water) physicists commonly write Bernoulli's equation in the form

$$gh_1 + \frac{p_1}{\rho} + \frac{v_1^2}{2} = g\,h_2 + \frac{p_2}{\rho} + \frac{v_2^2}{2} = \text{Constant} \quad [1]$$

in which

g = force of gravity on unit mass (or acceleration due to gravity)

h = the vertical distance of any point above horizontal datum

p = pressure intensity at any given point

ρ = density of the fluid

v = velocity at any given point.

In order to write Equation 1 in the form commonly used by engineers it is necessary to substitute for ρ its value in terms of g and w, i.e., force of gravity, per unit mass and per unit volume of water, respectively. By dimensional analysis it is easily seen that

$$\rho g = w \quad [2][4]$$

Substituting w/g for ρ in Equation 1, it follows that

$$g\left(h_1 + \frac{p_1}{w} + \frac{v_1^2}{2g}\right) = \text{Constant} \quad [3]$$

Remembering that $g = F/M$ and that each of the quantities inside the parenthesis of Equation 3 have the physical dimensions of length, L, it follows from Equation 3 that FL/M = Constant, i.e., the energy per unit mass of flowing water (ignoring friction) is constant.

The quantity g varies but little and is commonly considered in engineering usage as a constant. It is therefore evident from Equation 3 that

$$h_1 + \frac{p^1}{w} + \frac{v_1^2}{2g} = \frac{\text{Constant}}{g} = \text{Constant}^5 \quad [4]$$

The sum of the three terms on the left side of Equation 4 at any point is designated in engineering language as the "elevation of the energy grade line" (referred to any arbitrary datum plane), and the sum of the first two terms, i.e., $(h + p/w)$, as the "elevation of the hydraulic grade line[6]". The vertical distance of the energy grade line above the hydraulic grade line is thus equal to $v^2/2g$.

It is well known that expenditure of energy in overcoming friction is essential to make water flow. For steady uniform flow, v = Constant, and hence from Equation 4, if $(h_1 + p_1/w)$ represents the elevation of the hydraulic grade

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[3]For the ordinary velocities that occur in canals and pipes in which the flow is said to be turbulent the frictional force is considered proportional to the second power (square) of the velocity.

[4]$\rho = \frac{M}{L^3}$ $\quad g = \frac{F}{M}$ $\quad w = \frac{F}{L^3}$ $\quad \frac{M}{L^3} \times \frac{F}{M} = \frac{F}{L^3}$

Therefore, $\rho g = w$

[5]Equation 4 is Bernoulli's equation in the form ordinarily used by engineers. Each term on the left of the equality sign constitutes a length whereas, each term in Equation 1 has the physical dimensions of work (energy) per unit mass, i.e., FL/M.

[6]For extremely low velocities, such as usually occur in soils, the velocity head is negligible, and hence the elevations of the hydraulic grade line and the energy grade lines are substantially equal.

line at the upper end of a given length of pipe, l, and $(h_2 + p_2/w)$ the elevation at the lower end, it follows that the loss of energy per unit mass per unit length of pipe in overcoming friction L_e is given by the equation

$$L_e = \frac{g\left[\left(h_1 + \frac{p_1}{w}\right) - \left(h_2 + \frac{p_2}{w}\right)\right]}{l} \qquad [5]^7$$

Representing the quantity within the parenthesis by h_d, i.e., the difference in elevation of the hydraulic grade line, at the two ends of the pipe, it is evident that

$$L_e = \frac{g\,h_d}{l} \qquad [5_a]$$

The ratio h_d/l is commonly designated the "slope of the hydraulic grade line," or the "hydraulic slope" or the "hydraulic gradient." It is important to note that the length l is measured along the pipe and not along the hydraulic grade line. It is easy to see that this slope constitutes a ratio of length to length and therefore has zero dimensions.

Potentials, Potential Gradients, and Velocities. The potential in general is defined as the work required to move unit mass against conservative forces (ignoring friction) from any arbitrary reference point to any point in space. Gardner and his associates have defined the capillary potential as the work required to move unit mass of water from the level free-water surface against the capillary forces in the soil to any specified point in the unsaturated soil. The capillary water in the unsaturated soil is in tension; hence, the capillary pressures are negative, making the capillary potential also negative. The potential at a point, with respect to any arbitrarily selected horizontal datum plane, within a pipe through which water is flowing at a very low velocity, is given by $g\ (h_1 + p_1/w)$ in which h_1 is the elevation of the point in the pipe above the horizontal datum plane and p_1/w is the hydrostatic pressure head at the point. The change in potential per unit length of pipe is represented by the ratio

$$F_d = \frac{g\,h_d}{l} \qquad [6]$$

which is the driving force per unit mass in the direction of the flow of the water.

The meanings of the symbols F_r and F_d are given in a previous paragraph, and we may write from Darcy's law $K\,F_r = V$. Since $F_r = F_d = \frac{gh_d}{l}$, it follows that

$$V = K\frac{gh_d}{l} \qquad [7]$$

in which K is a proportionality constant having the physical dimensions of time (T).

Equation 7 asserts that where Darcy's law applies the velocity is proportional to the potential gradient due to the space rate of change in the combined head of position (h) and of hydrostatic pressure head (p/w). The measurement of change in h between any given points in a pipe of flowing water, or in a saturated soil, or a moist soil, is simply a matter of determining a difference in lengths. Likewise, in a pipe or a saturated soil through which water is flowing under pressure, measurements of differences in the pressure head, p/w, are easily made and generally understood among engineers; in an unsaturated soil the pressure head, p/w, is not so easily measured. This quantity in an unsaturated soil is essentially a capillary pressure head (sometimes called also negative hydrostatic pressure head) and the product $g\ p/w$ is equivalent to the capillary potential, i.e., the total work required to move unit mass of water from the free water surface against the capillary field force to any point in a moist soil.

[7]The quantity L_e of Equation 5 and 5a has the physical dimensions of F/M.

In any event, it would seem desirable that irrigation and drainage research engineers seriously endeavor to agree on definitions and usages in the study of capillary water flow

Applying Darcy's law to the rectilinear capillary flow of water in soils it follows from Equation 7 and the reasoning on which it is based that the velocity of capillary flow is given by the equation

$$V = K\frac{gh_c}{l} \qquad [8]$$

in which h_c is the difference in "head" due to the combined effect of position and of capillary pressure; the product gh_c is the difference in potential due to position and to capillary pressure head between two points along the stream lines separated by a distance l.

The ratio h_c/l of Equation 8 is analogous to the ratio $\frac{h_d}{l}$ of Equation 7 which is the slope of the hydraulic grade line. The ratio gh_c/l is the potential gradient in an unsaturated soil[8].

Buckingham early suggested the measurement of the capillary potential difference as a means of studying the flow of capillary water. More recently Gardner and Richards have materially advanced the methods of making measurements of capillary potential differences.

Discharge of Water Through Soils. Because of the difficulty of measuring accurately the cross-section area of stream lines in a given area of soil at right angles to the direction of water flow, direct measurements of velocity of flow of water in soils (either saturated or unsaturated) are relatively of less value than direct measurements of velocity for canals and pipes. As the desired objective is to measure the volume of flow per unit time through a soil of given area normal to the stream lines, it is probably advisable to use directly an equation for volume rate rather than one for velocity.

Let A = any given area normal to flow.

a = the summation of cross-section area of soil spaces through which water flows when saturated and also of the irregular capillary water channels in an unsaturated soil, in the soil area A

Then $P_f = a/A$, i.e., the fraction of the area A through which flow occurs[9]. It follows from the general equation of discharge $(q = a\,V)$ and from Equation 8

$$q = P_f\,AV = P_f\,K\frac{gh_c}{l}A \qquad [9]$$

It is quite impractical to measure P_f with precision; hence, it is desirable to replace the product $P_f\,K$ by a new quantity, k, having also the dimensions of time and write Equation 9 in the form

$$q = k\frac{gh_c}{l}A \qquad [10]$$

It is apparent from Equation 10 that, if the ratio gh_c/l equals unity, and A equals unity, then $q = k$ (numerically). The quantity, k, is therefore defined as the quantity (volume) of water that will flow in unit time through a soil column of unit cross-section area due to the driving force

[8]The slope of the hydraulic grade line has zero physical dimensions, whereas the potential gradient has the dimensions of force per unit mass.

[9]It is suggested by Major O. V. P. Stout, irrigation division, U.S.D.A. Bureau of Agricultural Engineering, that this fractional area P_f be designated the effective porosity.

Table I. Some Equations Giving the Quantity of Water That Will Flow in Unit Time Through a Given Area of Soil

1	2	3	4	5	6
				Transmission or Conductivity Factor	
	Authors	Saturated or Unsaturated Media	Equation	Symbol	Physical Dimensions
1898	Slichter	Saturated	$q = kh/l\ A$	k_s	$L\ T^{-1}$
1900	Hazen	Saturated	$q = C\ d^2 h/l\ A$	C	$L^{-1}\ T^{-1}$
1907	Buckingham	Unsaturated	$q = \lambda\ S\ A$	λ	T
1920	Gardner	Unsaturated	$q = K \frac{p}{\rho\ 4/3} A$	K	$M^{1/3}\ L\ T^{-1}$
1921	Gardner, Widtsoe	Both	$q = K\ \rho\ \Delta\ \phi\ A$	K	$L^3\ T\ M^{-1}$
1928	Gardner, Israelsen McLaughlin	Saturated	$q = k \frac{d\ \phi}{d\ r} A$	k	T

q = volume per unit of time, i.e., $L^3\ T^{-1}$
h/l = the slope of the hydraulic gradient, having zero physical dimensions
A = total cross-section area normal to flow, i.e., L^2
d = the effective diameter of sand grains, i.e., L
$\left.\begin{matrix} S \\ \Delta\phi \\ \frac{d\phi}{dr} \end{matrix}\right\}$ = the potential gradient i.e. $F/M = LT^{-2}$
ρ = moisture density, mass of water per unit volume of total space occupied by dry soil, water, and air, i.e., $M\ L^{-3}$
p = the space rate of change of ρ, or the "moisture density gradient", i.e., $M\ L^{-4}$

per unit mass corresponding to unit potential gradient. It is suggested that the quantity, k, be designated as the "specific water conductivity."

Flow in Saturated and Unsaturated Soils. So long as the quantity of moisture in unsaturated soils is sufficient to provide continuous capillary channels, there is fundamentally little, if any, difference in the laws which influence the flow of water in saturated and unsaturated soils. The law of Darcy applies to both[10]; the specific water conductivity, k, is probably smaller in the unsaturated soils than in saturated soils, due in part to the smaller net cross-section area of capillary channels being smaller than the cross-section area of the water channels in a saturated soil, and in part to the greater frictional resistance of the capillary channels, because of their being smaller than the water channels in a saturated soil of the same apparent specific gravity.

A review of the literature concerning the flow of water in porous media, such as soils, filter sands, porous rocks, etc., reveals considerable variation in usage, even though the applications of basic principles of flow are essentially similar. Darcy's law is applied in the study of flow, both in saturated and in unsaturated media. Without attempting to review fully the literature, a few examples of different usages are cited. The equations credited to each of the several authors have been brought to a common basis for measure of quantity of flow (volume) per unit of time through any given area, A, in order to simplify comparisons. The symbols used in Column 4 of Table I are explained following the table. That part of each equation which constitutes a proportionality factor and which is designated by some as a "transmission constant," by others as a "transmission coefficient," and by still others as "conductivity," is given in Column 5 of Table I; its physical dimensions are recorded in Column 6.

[10]For very high gradients the law of Darcy does not apply with precision.

The fact that the conditions which influence the flow of water in soils are even more complex than those which influence its flow in rivers, canals, and pipes adds to the urgency of the need for using the well-established basic physical laws concerning the flow of liquids and for adoption of a basic equation of general application.

In studying the flow of capillary water during recent years, physicists have concentrated attention on an experimental determination of the specific water conductivity, k, which, as shown in Table I, has the physical dimensions of time, T. Engineers, following the lead of Slichter in a study of the flow of water in saturated soils, have used largely the transmission constant, k, which has the physical dimensions of velocity, i.e., $L\ T^{-1}$. Thus there has developed rather an artificial barrier separating two phases of one general problem. It is probable that greater recognition of the problem of flow of water in soils (whether saturated or unsaturated), as one general problem having distinctly common elements will accelerate progress in ability to measure or predict the flow under a given set of conditions.

Specific Water Conductivity. The variations in usage for, and meaning of, the transmission or conductivity factor as reported in Columns 5 and 6 of Table I seem to warrant the belief that attempt toward coordination and uniformity of usage is desirable. It is not the author's purpose to urge any particular usage; it is rather the purpose to suggest and to invite discussion.

As a basis for discussion, it is suggested that the specific water conductivity, k, as heretofore defined, be used by irrigation and drainage research workers in the study and reporting of data concerning the flow of water both in saturated and in unsaturated soils. The bases for making this suggestion, briefly stated, are as follows:

1. The inclusion specifically (rather than implicitly) of the quantity, g, force of gravity per unit mass, in an equation for ground water flow is fundamentally sound, because it is obvious that water flows in response to the action of a conservative force on each unit mass.
2. The specific conductivity, k, having the physical dimensions of time (T), permits the transfer from foot-pound-second units to centimeter-gram-second units without changing the numerical value of k.
3. Flow of water in saturated and unsaturated soils (except for very high potential gradients) obeys Darcy's law and should therefore be represented by one equation of general application.
4. The usage of a conductivity factor, k, having the dimensions of time, T, in the writings of physicists is now quite general; the use of a factor having the dimensions of LT^{-1}, such as k_s in engineering literature, likewise is quite general. Bringing the two usages to a common basis will facilitate understanding of the contributions made by each group toward the solution of the ground water flow problem.

CONCLUSION

It seems apparent from a study of the literature on the flow of water in soils that coordination in usages and in definitions is rather urgently needed. Thorough discussion may show that no attempt should be made to modify or discontinue the use of Slichter's "transmission constant for flow in saturated soils," here represented by k_s, which is

now widely used and well understood by engineers. In any event, it would seem desirable that irrigation and drainage research engineers seriously endeavor to agree on definitions and usages in the study of capillary water flow. Probably the specific water conductivity, k, varies with many factors; for example, soil texture, structure, pore space, temperature, alkali content, and moisture percentage. Agreement upon the use of a basic equation of general application to steady flow would probably encourage research workers to concentrate attention upon obtaining data that will make possible the determination of some one important quantity such as k. That substantial progress has been made in a study of the flow of water in canals and pipes by an experimental determination of the coefficient of roughness, n, under widely varying conditions is clearly apparent to engineers.

The fact that the conditions which influence the flow of water in soils are even more complex than those which influence its flow in rivers, canals, and pipes adds to the urgency of the need for using the well-established basic physical laws concerning the flow of liquids and for adoption of a basic equation of general application.

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Factors Affecting Grades of Cotton

By D. Howard Doane[1]

DURING the past three years the Doane Agricultural Service, with the cooperation of the Mississippi Agricultural Experiment Station and the Delta Laboratory of the U.S.D.A., has been studying factors affecting grades of cotton. Most of the work was conducted on or with cotton produced on the Robertshaw Plantation, Heathman, Mississippi, which is managed by the Doane Agricultural Service.

Field and gin practices including picking, harvesting, cleaning and drying, were studied in their relation to their influence on grading of the cotton produced, and on general farm management methods. It is believed that the conclusions reached will be of interest to agricultural engineers; the figures on which they are based are available from the Doane Agricultural Service[2]. The following are the conclusions reached.

1. A drier materially improves grades when used at the beginning of the season on green cotton, or on older cotton when picking or ginning is done on rainy days, or during periods of heavy dews.

2. Drying reduces weight but no accurate measurement of the amount has been obtained.

3. Drying under some conditions appears to shorten staples.

4. Well-matured cotton, picked in good weather is not helped and might be hurt by drying.

5. The drier increased the number of days available for picking and ginning during the early season and during damp weather.

6. The drier increases the efficiency of gins by eliminating stops and breaks due to wet cotton, and practically eliminates deductions for poor preparation.

7. There was no accurate way of determining cost of drying cotton, as the steam and power plants for drying were part of the ginning units. The best estimates, based on increased use of coal, labor, etc., place the cost at about 50 cents per bale. This does not include interest on investment in drier, depreciation, maintenance or loss in weight of cotton.

8. The use of the cleaner for the 1930 season appears to confirm the results of previous tests. From $1 to $2 a bale was added to the value this year. This is in keeping with previous results, when the cleaner added from $5 to $7.50 a bale. Cleaning and drying are better than either one alone, when both are needed.

9. The grade of early-picked cotton appears to be improved by sunning, or seasoning in a cotton house. The degree of improvement appears to be about equivalent to that of drying.

10. Steaming, as done in these tests, did not bring back a shortened staple or materially improve the rather harsh feel of cotton that had been overdried. Letting samples stand near an open window for over a month did not change staple length. When the temperature of drying was correctly controlled, criticism from graders on the "feel" of the cotton samples was eliminated.

11. The snapping of cotton while still white holds much promise. With the use of cleaners and driers it appears that the loss in grade is not as great as the saving in cost of harvesting. With some care used in snapping and handling it seems that snapped cotton closely approaches picked as to grade and character.

12. Tests of various pickers justify no very definite conclusions.

13. The feeling that new and modern gins and cleaners are materially superior to older standard gins does not appear to be justified in the tests made this year and in former years.

14. A comparison on two different plantations using the same varieties shows that early maturity and early picking are important factors favorably affecting grades.

15. The average value of two prominent varieties of cotton tested against our variety shows a slightly greater value for the other varieties. This test does not compare yields, a most important factor.

16. Early dying and some blight did not appear to be unfavorable to grades.

17. Tests during previous years showing the effect of the cleaner on early-picked cotton were not favorable to the cleaner. On cotton picked later the results were unusually good. The added value was as great as $8.70 per bale.

18. There appears to be little relation between rapidity of picking and grade. The cotton of pickers who are considered careful pickers by their managers shows a somewhat higher index number than cotton picked by ordinary or poor pickers under the same conditions, although the difference was small.

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The Use of Mechanical Refrigeration for Farm Egg Storage[1]

By P. T. Montfort[2]

THE use of mechanical refrigeration for storing quantities of eggs on the farm is an entirely new thought to most of us. It is as yet almost wholly in the experimental stage, there being in operation at the present time only about ten installations of this kind, with a total storage capacity of approximately 6000 cases of eggs. However, from the experience of those poultrymen who have been using this type of storage for the past two or three years, the possibilities for profit to the farmer appear unusually bright.

Of the total annual egg crop in the United States, approximately 50 per cent is produced during the months of March, April, May and June. As a result, large quantities of eggs must be stored through periods varying from four to eight months in order that a constant supply may be available to the consumers of this important staple in our daily diet. Ordinarily about 15 per cent (reaching a total of approximately 12,000,000 cases in 1930) of the annual egg production goes into storage. In spite of a growing tendency to lengthen the producing season and shorten the period of under-production by more scientific methods in the management of poultry flocks to obtain greater egg production during the winter months, there appears no immediate prospect that the volume of eggs stored will be materially decreased.

The egg is a delicate and fragile product and under unfavorable conditions, particularly at high temperatures such as commonly prevail during the period of heaviest production, is subject to rapid deterioration. Consequently, if eggs of high quality are to be available at the end of the storage period, carefully controlled conditions must be maintained throughout the trip from the producer to the consumer. They should be carefully graded and packed in new, clean containers. To obtain the best quality of product, refrigeration facilities should be available throughout as much of the trip as is possible. This requires a tremendous investment in facilities for refrigeration at the point of assembly, during shipment, and in the storage warehouses, as well as some means of efficient refrigeration during distribution to the consumer. Since this continued refrigeration is not always available under the present system, one of the most important costs of storing eggs is the loss due to deterioration — often to the extent of complete spoilage.

Under normal conditions, the supply of fresh eggs is lowest during the winter months. Because of this scarcity and the cost of providing high-quality cold storage eggs, these months ordinarily constitute a period of high egg prices. In Fig. 1 is shown the average monthly prices as quoted on the New York Exchange during the period from 1925-30 inclusive on "selected extra" eggs. In this figure is also shown the average of monthly prices received during 1928 and 1929 for fresh eggs at the Texas A.& M. College Poultry Farm. A study of the New York prices discloses a spread of $7.50 per case between the average price for March, April, May and June, and the November or peak price. The prices received at College Station show a spread of $6.37 per case between the corresponding periods. An analysis of prices obtained by the Poultry Producers Association of San Antonio, Texas, during 1928 and 1929 shows a spread of $5.10 per case between the prices prevailing in the spring months and those paid during November and December. This spread of price between the periods of high and low production serves as an indication of the limits in normal years within which the cost of storing eggs must be maintained if a profit is to be obtained.

In times of abnormal conditions such as the winter of 1930-31, when there was a tremendous volume of storage eggs on hand and an unprecedented supply of fresh eggs made available because of the mild weather, the period of high prices does not always materialize. Such conditions usually cause tremendous losses to the owners of eggs held in cold storage. Such possibilities must be kept in mind when considering the cost of storing eggs.

If the farmer is to store his eggs successfully, he must have some means by which he can maintain a constant low temperature and a proper condition of humidity. His storage vault must be free from objectionable odors since eggs very readily absorb such odors from the surrounding atmosphere. Apparently most authorities have agreed on the correct temperature for storing eggs. The lowest temperature possible without causing solidification of the egg content should be maintained. The usual range in commercial storage is from 28 to 30 degrees (Fahrenheit). It is of particular importance that a constant temperature be maintained since a variation of more than one or two degrees will cause a breaking down of the egg albumen, because of the alternating contraction and expansion, resulting in what is known as a "watery" egg.

The problem of humidity is one which apparently has not yet been definitely solved. It is desirable that the humidity be kept as high as possible without the formation of mold. A storage room which is kept too dry results in the absorption by the air of moisture from the egg content, leaving an enlarged air cell. A humidity of 82 to 85 per cent is probably the most desirable under normal conditions.

So far as can be determined, the present limited development of this method of storing eggs on farms has taken place in a somewhat restricted area in north and northwest Texas. In the spring of 1927, W. F. Robinson, a poultryman, placed a few cases of eggs in storage at Wichita Falls, Texas, about forty miles from his farm. This ven-

[1]Paper presented at the Rural Electric Division session of the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June 1931.

[2]Research agricultural engineer, A.& M. College of Texas, and director, Texas Committee on the Relation of Electricity to Agriculture. Assoc. Mem. A.S.A.E.

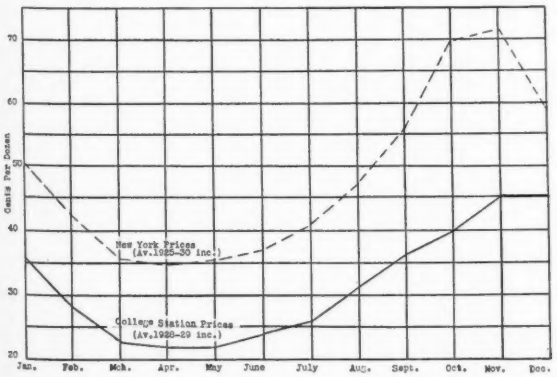

Fig. 1. Average monthly prices of eggs as quoted on the New York Exchange during the years 1925 to 1930, inclusive; and those received at Texas A.& M. College, during 1928 and 1929

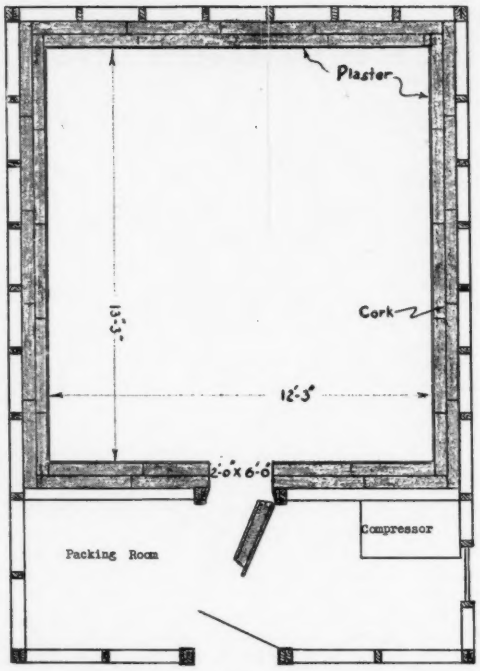

Fig. 2. (Left) Plan of an 800-case egg storage vault.

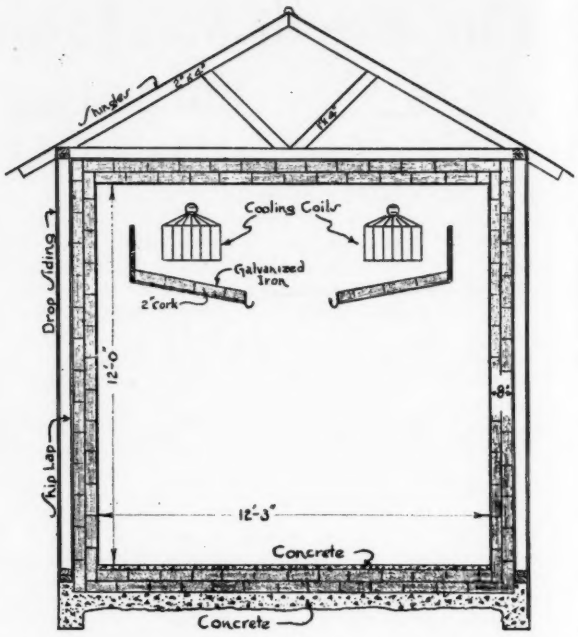

Fig. 3. (Right) Section of an 800-case egg storage vault

ture proved entirely satisfactory from the standpoint of profit to be obtained by storing eggs during the period of low prices in the spring and holding them until the time of greater demand during the winter months. He made plans to store a considerable quantity of eggs in the same vault during the season of 1928, but when the time came for storing, all available vault space had been leased to one of the large packers and he was without storing facilities. There followed a conference between Mr. Robinson and A. A. Sadler[3] which resulted in the design and construction at Mr. Robinson's farm of a cold storage vault with a capacity of 500 cases of eggs. The total cost was about $2100. This included an automatic water system to supply cooling water for the compressor.

During the first season this vault was filled to capacity and the eggs sold at the end of a six months period to local jobbers. A profit of approximately $5.00 per case was realized which resulted in Mr. Robinson's being able to pay for his entire equipment from one year's operation.

Because of the unusual success of this venture in storing eggs on the farm, five additional installations were made in the same locality in 1929. Three of these vaults of 800-case capacity each were constructed on a single large poultry farm, one of 500-case capacity at a smaller poultry farm, and one of 800-egg capacity was installed in a small town by a merchant who purchased a considerable quantity of eggs from local farms.

All of these plants operated during the season of 1929 with very satisfactory results and in the spring of 1930, four additional units were built in other sections of north and northwest Texas. One of these units was installed by a poultryman so located that electric power was not available. This unit has been operated fairly successfully with a gasoline engine controlled manually.

Figs. 2 and 3 show the plans used in constructing the farm cold storage vaults. The walls are of ordinary frame construction with 2x4 studs ceiled inside with shiplap. The outside wall is of drop-siding. In all vaults which have been constructed, the space in this wall has been filled with cotton seed hulls well tamped. However, there is some question as to the advisability of using this material since there is a possibility of its becoming water logged by the absorption of water from the air. The insulation in the vaults consists of 8 inches of cork board, two thicknesses of 4 inches each, laid in asphalt with all joints overlapped. Six-inch concrete floors insulated with 8 inches of cork board are used. The ceiling is insulated with 8 inches of cork on top of which is a 6-inch layer of hulls. Inside walls and ceiling are coated with a half-inch layer of plaster while the floor is covered with one to two inches of concrete.

The doors were purchased from a manufacturer of refrigerating equipment at a cost of approximately $50 each, including hinges, fasteners, and door facings.

The inside dimensions for an 800-case vault are 12¼ by 13¼ by 12 feet. The cost complete was approximately $2300. Inside dimensions of the 500-case vault are approximately 10½ by 10½ by 12 feet, and the cost about $2000.

One Model "C" Frigidaire compressor operates four "96-F" coils to cool the unit. The coils are suspended from the ceiling. Two L-shaped baffles immediately under them provide for air circulation.

Eggs for storage are placed in cases without flats and fillers. In this way considerable economy of space is accomplished since approximately 55 dozen eggs can be placed in each 30-dozen case. This is also supposed to provide for a more satisfactory circulation of air around the eggs. The tops are left off the cases which are stacked with only a thin lath between. One-inch strips are placed on the floor under the cases and a space of from one-half to one inch is left between cases and between the cases and walls to provide for air circulation. The strips on the floor and the laths between cases are placed crosswise to the baffles.

Apparently it has been possible to maintain constant and uniform temperatures in these boxes. The temperature at which the eggs are held has varied in the several installations depending upon the desire of the operators. The majority of the boxes are kept at a temperature of 30 degrees (Fahrenheit), while one is operated at 32 degrees and one at a temperature of 34 degrees.

[3]Local distributor of Frigidaire products at Bowie, Texas. Credit is also due F. B. Martin of the P. M. Bratten Company, Frigidaire distributors at Fort Worth, Texas, for assistance in the development of the first farm egg storage unit.

In August 1930, watthour meters were placed on the motors operating the compressor units of two of these installations, one 500-case unit and one 800-case unit. Fig. 4 shows the energy consumption at these two installations during the five-month period from August to December, inclusive. During this five-month period the energy consumption by the 500-case unit was 1.69 kilowatt-hours per case, while the 800-case unit used 2.18 kilowatt-hours per case. The fact that the higher energy consumption resulted in the case of the larger vault may be partly explained by the fact that other products such as watermelons, butter, and milk were kept in the vault for household use. This necessitated frequent opening of the vault which probably caused considerable variation in the temperature maintained. This may partially account for the deterioration noted near the end of the season in quality of the eggs. However, the cases were very poorly spaced in this unit and some eggs of doubtful quality were put into the vault during the season.

From experience gained in the operation of these vaults during the past three years, there has been very little deterioration in the quality of the eggs when proper care was exercised in placing the eggs in the vault and when only clean, fresh, high quality eggs were placed in storage. During the season of 1930, two instances of losses were reported. One was apparently due to the fact that insufficient space was left between cases to provide for proper air circulation which resulted in some eggs molding. In the other instance, which occurred at the vault owned by the merchant who purchased eggs from nearby farms, proper care was evidently not maintained in selecting the eggs which were placed in storage, particularly during the late spring months when outside temperatures were high.

Since this method of storing eggs is a comparatively new development, a project to determine more definitely the operating characteristics of this type of equipment has been outlined and is now being carried on cooperatively by the Texas Committee on the Relation of Electricity to Agriculture, the Frigidaire Corporation, the Texas Electric Service Company, and the farm operators. The following quotation taken from the formal outline of the project will give an idea of the scope of the present study.

"Object: To determine the practicability of an electrically operated farm cold storage unit for eggs.

"Method of Procedure: Records will be kept on the operation of at least three farm installations as follows:

"1. Date eggs placed in refrigerator; number and condition of eggs, and market price

"2. Date eggs removed, price at which sold, quality of eggs (quality to be determined by expert egg grader)

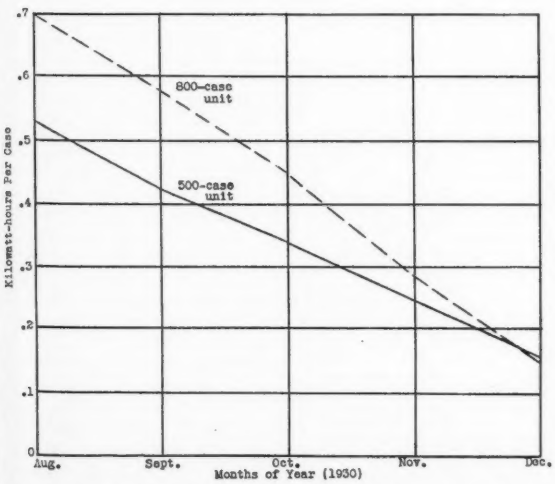

Fig. 4. Energy required to cool eggs in two farm storage vaults

"3. Recording thermometers and hygrometers will be placed in each vault to determine the temperature and humidity maintained

"4. A watthour meter and a recording ammeter will be placed on each motor operating the compressor units to determine the amount of energy used and the operating time of the machine."

The demoralized egg market during the fall and winter of 1930-31 resulted in tremendous losses to the majority of those owning eggs in storage whether in commercial or privately owned vaults. Those farmers who had eggs in privately owned vaults and sold them at the normal season during November and December suffered no serious losses. The majority of the operators had, however, stored their eggs with the expectation of reaping unusual profits and held them with the hope of securing better prices, until later in the season. Some owners sold the bulk of their holdings as late as February and March of this year. Without exception, those who held their eggs over took considerable losses in some cases not only because of low prices, but also on account of deterioration in quality after the eighth month of storage. As a result of the hectic conditions prevailing throughout the past season, several of these farm operators have been rather hesitant about storing eggs during this year.

Since the production from approximately 3000 hens (based upon 50 per cent production) is required to fill one of the 500-case units, it is apparent that the equipment now being installed is not suitable for the farmer or poultryman with a smaller flock. There is a possibility, however, that these vaults could be built and operated successfully in smaller units, although in this instance the investment charges per case of eggs stored would be somewhat higher. There is the possibility that the storage facilities could be used very satisfactorily by a group of neighboring farmers or small poultrymen under a cooperative arrangement. It is possible also that the overhead expense on these installations might be reduced materially by using them for other purposes, such as curing meats or storing other farm products when not filled with eggs. Each of these possibilities presents an opportunity for further investigation.

Machines Save Us from Chronic Depression[1]

SINCE the depression had to happen—so we are told—we might as well enjoy the amusing things connected with it. One source of smiles is the analysis of the trouble by amateur economists.

The machine, we are solemnly told, is the guilty author of all our economic distress.

The arguments for a return of the old handwork era are strangely unconvincing. They lack detail. Somehow it is hard to imagine an old weaver, up before dawn at his loom, tied to it through a long day because there were not enough hours to produce more than a pitiful income, as romping gayly through his task and having time to take joy in his work.

* * * * * * *

Distress is a result of faulty distribution. But that condition always existed, and is not caused by the use of power. Strictly speaking, unindustrialized countries are in a chronic state of depression. Endless toil at hand crafts. trying to raise crops on unproductive farms, earning a poor living by muscle power, these are only other ways of standing in the bread line. Men are as much slaves when driven to a long day at back-breaking toil as when called by the factory whistle—if the work is irksome. The only difference is that industrial progress has shortened the period of slavery.

The engineer has led the way to progress. The task of equalizing distribution remains a challenge.

[1]Engineering Experiment Station News (Ohio), Vol. 3, No. 5 (October, 1931).

Status of European Corn Borer Control[1]

THE natural spread and increase of the European corn borer, which was retarded by the abnormal season of 1930, was resumed in 1931. The intensity of infestation in 1931 was about two and one-half times that of 1930 and more than twice that of 1929. Although the past season cannot be regarded as having been exceptionally favorable for the corn borer, some of the serious infestations recognized as possible in the 1930 report of this committee actually occurred. As a result, there is a much larger number of larvae at present than in the fall of 1930, with a consequently greater danger for 1932. The increase in borer population was particularly heavy (1) in northwestern Ohio, south of the former center of infestation along Lake Erie, and (2) in the important sweet corn area along the southern and eastern shores of Lake Ontario in New York.

The present infested area includes all of the corn-growing areas in Canada, excepting the western provinces; also 220,000 square miles in the United States, including the southern two-thirds of New England, northern part of New Jersey, all of New York, three-fourths of Pennsylvania, the panhandle of West Virginia, practically all of Ohio, the northeastern half of Indiana and nearly all of the agricultural portion of Michigan. In the area east of the Connecticut River in Connecticut, Massachusetts, and states north, in that territory in Connecticut west of the river adjacent to Long Island Sound, and in restricted localities in New Jersey, the two-brooded form occurs, while in all other infested sections of the United States and all infested areas in Canada, excepting Nova Scotia and New Brunswick, only the one-brooded form occurs. Small isolated infestations occurred in eastern Wisconsin, Kentucky, and extreme southern Indiana.

The increase in spread and infestation in 1931 further demonstrates that seasons of increase and decrease in borer abundance will occur as with other crop pests. Temporary checks to the corn borer in individual seasons, such as that in 1930, must not be interpreted as minimizing the seriousness of the insect as a destructive agency.

The large increase in borer population in 1931 emphasizes that the European corn borer is one of the most potentially destructive crop pests ever introduced into America. This fact calls for the continued cooperation of the farmer, the scientist, the educator, and all state and federal administrative officials.

The joint committee of entomolgists, agronomists, agricultural engineers, agricultural economists, and animal husbandmen commends the efforts of all farmers practicing recommended control measures and of those engaged in the research, regulatory, and educational activities.

The committee recognizes the necessity for the continuation of the research, educational, and quarantine programs of the state and federal governments and earnestly recommends the appropriation of the funds needed to maintain and, if necessary, to expand them as suggested later in this report. The committee recommends this support only after due consideration of the absolute necessity of holding current governmental expenditures to a minimum.

After careful investigation of the regulatory, research, and educational activities, the committee suggests and recommends:

1. Since the enforcement of quarantine regulations in the United States has undoubtedly been instrumental in preventing long-distance spread of the insect in the past, that this activity of the federal governments of the United States and Canada, as well as the state and provincial governments, be supported and encouraged by all agencies and individuals interested in the welfare of American agriculture. These activities should include (a) thorough scouting, (b) careful clean-up of isolated infested areas, and (c) maintenance of quarantines.

2. That the extension agencies of the federal governments of the United States and Canada and of the state and provincial agricultural colleges, strengthen and coordinate their programs of education relating to the corn borer, extending these to conform with the spread and abundance of the insect and with the increased knowledge gained through research.

3. The entomological investigations now in progress should be continued. The following studies on which material progress already has been made, should be especially stressed: (a) The expedition of parasite introductions and the development of artificial media for mass production of parasites, (b) the development of effective insecticides and their efficient application, (c) evaluation of the effect of environmental factors on the insect's activity.

4. While the development of immune varieties seems unlikely at this time, experiments point clearly to the probable development of high-yielding resistant and tolerant varieties of corn which should be an important factor in control. To promote the development of such varieties, the corn-breeding programs of the state and federal governments should be continued and strengthened.

5. Inasmuch as control of the borer, as yet, depends largely upon mechanical means in the hands of growers, it is recommended that research and development work along mechanical lines by the agricultural engineers be continued and be strongly supported by the federal government and by the states, with a sincere effort being made to coordinate such activities through the U.S.D.A. Bureau of Agricultural Engineering. In such work it is recommended that attention should be directed first toward machine types now common on farms, in view of the fact that agriculture cannot easily avail itself of new types of equipment primarily for control until it has used to the best possible advantage the equipment now on farms.

Attention is drawn to the fact that considerable development work has been accomplished and now awaits adoption by the various extension forces and by the manufacturers of farm equipment. It is recommended that the extension forces bear in mind that the better use of equipment now on farms is to be fostered.

The manufacturers are to be commended for their interest and loyal support in corn-borer work to date, and, in spite of the readjustment period, it is hoped that they will continue rapidly to convert development accomplishments into the commercial channels, so that the growers, who must carry the burden of control, will not be handicapped by the latest, practical, mechanical devices not being available to the public.

6. Since the corn-borer control practices developed and proposed may change the organization and income of the farm, it is important that the relation of these practices to the entire farm business be determined and recommendations made for specific conditions. Proposals including changes in cropping systems, complete utilization of corn, substitute crops, changes in corn acreages, and labor and equipment costs should be worked out in line with the objective of maximum returns from farming.

7. Continued and further studies should be made on the influence of different borer populations upon (a) the feeding value of corn and the corn plant in different forms, (b) the yield of feed nutrients per acre, (c) comparative feeding value due to different methods of harvesting and preparing crop, (d) the use and feeding value of substitute crops, and (e) the influence of the corn borer and resultant control measures upon the cost of production and the quality of livestock products.

[1]Report (September 30, 1931) of the Joint Committee on the European Corn Borer representing the American Association of Economic Entomologists, the American Society of Agronomy, the American Society of Agricultural Engineers, the American Farm Economic Association, and the American Society of Animal Production. The personnel of the A.S.A.E. representation on this joint committee consists of C. O. Reed (chairman), R. D. Barden, R. B. Gray, W. C. Harrington, and A. L. Young.

Electric Dairy Stable Ventilation[1]

By F. L. Fairbanks[2]

WHY do we want electric ventilation for the dairy stable? It is evident that there is a demand for this type of system. Companies are making these systems and selling them; farmers are inquiring about them, and the power companies are interested. But why the electric system?

It seems to be a combination of circumstances. Commercial natural-draft systems, due to their design, manufacturing, and marketing requirements, cost the farmer more than he feels he wants to pay for ventilation. Electricity is rapidly being applied to farm jobs, and it can be readily seen that the selling price of an electric system for a given job can be made less (by the elimination of multiple high-outtake flues and the accompanying installation cost) than that of the commercial natural-draft system. Also, I feel that the system developed at Cornell University has introduced some new factors which are having a decided influence toward the simplification and dependability of the ventilation system for the dairy stable, two chief factors of which are the single floor outtake and its location and the design and placing of the intakes, which factors fit admirably into the scheme of electric ventilation.

The electric system will probably not replace the natural-draft system, but it seems to have a place and should be satisfactory both from the standpoint of the farmer and of the power company.

The need for ventilation is accepted, but have we carefully thought out and boiled down just what we wish to accomplish by ventilation. If we have done this, then we should be able to adapt and perfect apparatus for doing the job. It would also be helpful to have a set of standards to work to, not only for the purpose of design but also as a means of measuring the effectiveness of the system, and I, therefore, propose the following standards:

1. The temperature of the stable should be from 45 to 50 degrees (Fahrenheit) with an allowable variation of 10 degrees for extremes in weather conditions.

2. The relative humidity should be maintained at about 75 per cent, and not over 85 per cent.

3. The air flow through the stable may vary from 40 to 80 cubic feet per minute per cow.

4. Complete mixing of incoming air with stable air to insure a uniform quality of air throughout the stable.

5. The convection currents in the stable should be positive at all times; that is, they should be constantly in operation to insure complete mixing of fresh air and stable air and to assist in the diffusing of the fresh air.

6. Intakes should be so constructed that the velocity of the incoming air is reduced, as it enters the stable, to such a degree that no objectionable drafts can possibly result. (An objectionable draft is a stream of air which is of lower temperature than the surrounding air and which blows directly on to an animal or attendant.)

These conditions which may be termed standards, are stable conditions which prevail when the stable is adequately ventilated, and, as many of you realize, there are many stables today in which just such satisfactory conditions exist, and still a larger number in which they do not.

There are four types of gravity systems now in use which to a lesser or greater extent measure up to these standards. They are (1) the modified Rutherford system, (2) the Rutherford system, (3) the King system, and (4) the Fairbanks-Goodman system.

The electric ventilation systems now being developed are following the design and incorporating features of the above systems.

Intakes. An important point to consider in connection with any ventilation system is that, if you provide means for exhausting air from the stable, you must provide openings through which fresh air may be admitted to the stable to replace the exhausted air, and also that the placing of these openings is all important as it affects the distribution of the fresh air.

The theory of admitting air through leaks certainly does not hold with the theory of making the walls of the stable tight and warm, and further than that, if anyone will measure the leaks in a modern stable, he will find the area far below that required for adequate ventilation intakes. Still further, the leaks are always at the wrong place and are never uniformly distributed around the stable.

Control. With the electric ventilation system the flow of air through the stable would be constant under all conditions, if we assume that the fan capacity is constant. Do we want a constant flow through the stable under all weather conditions? The designers of the present electric ventilation system seem to think that we do not. Therefore, they have designed their systems for a maximum flow and made provision for reducing the flow, or of stopping it entirely in order to maintain a certain temperature in the stable, which is the chief factor on which the idea of control seems to rest, as well as the fact that the general weather conditions—which may be grouped as follows: (1) normal winter weather, (2) extreme cold winter weather, (3) mild winter weather, (4) between-seasons weather (fall

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Rochester, New York, October 1930.

[2]Assistant professor of agricultural engineering, Cornell University. Mem. A.S.A.E.

The electric system will probably not replace the natural-draft system, but it seems to have a place and should be satisfactory both from the standpoint of the farmer and of the power company

and spring), and (5) summer weather—affect the ventilation conditions in the stable.

The methods of control at present are (1) automatic by thermostat, (2) manual, (3) constant speed fan, (4) variable speed fan, (5) constant speed fan with fan tube dampers, (6) combination of ceiling and floor outtake tubes, and (7) multiple constant speed or variable speed fans.

Of these types I have observed the operation of (1) ceiling intake, ceiling outtake fan with fan tube damper and thermostat control, and (2) ceiling intake, floor outtake fans, constant speed, thermostat control.

These systems were installed in the same stable which had a capacity of 55 cows. The stable was 47 feet wide by 70 feet long; there were five stanchion rows across the narrow way with a 6-foot aisle along the west wall (the ridge being north and south). The east wall was masonry banked. One-half of the south wall was masonry banked; the other half of the south wall was single board. The west wall was single board, and the north wall was about one-quarter single board and three-quarters partition between the silo space and store room and the stable. Therefore, approximately one-half of the wall area was warm and one-half cold.

The single-board wall had a few leaks, and the three doors on the west, the one on the north, and the one on the south leaked badly.

INSTALLATION

The two ceiling outtake fans were located on the east side and served approximately equal areas.

The two floor outtake fans were located on the south wall.

There were five intakes on the east, four on the south, seven on the west, and one on the north.

The thermostats were placed at the ceiling about 15 feet from the west wall and between the second and third rows of cows; the first three rows being heavy Holstein milking stock, the fourth row yearlings, and the fifth row calves and two box stalls.

The three rows of milkers were out about one hour each day and the fourth and fifth rows of young stock out about eight hours each day. This made an ideal arrangement. During the day-time the stable was approximately at 60 per cent capacity and during the night 80 per cent, with the light-weight stock in the single-board end of the stable.

You see the possibilities: Sixty per cent stock capacity during the day to observe the control of the two systems and the effect of leaks; at night, 80 per cent capacity.

The general weather conditions to be hoped for for test purposes were normal, mild, cold winter weather, between-seasons weather, and summer weather.

These conditions were observed and some interesting high points resulted. These were

1. The effect of no intakes as compared with intakes
2. The effect of air leaks
3. The difference in temperature control
4. The difference in air conditioning.

Although the exhaust fans were of amply capacity, the stable air conditions were very poor without the intakes, the most noticeable effects being the strong stable odor, such as is present in unventilated stables. This was due to the lack of distribution of the incoming air and I think probably to reduced flow. Two of the stable walls were practically air tight, and the leaks from the other walls were supposed to supply the fresh air. There was, of course, not enough area in the leaks to supply the fans, and the leaks were in such a position that they could supply air only to a part of the stable. Although some moisture was being removed, the air appeared to be stratified, with cold air drafts on the floor and stuffy, ill-smelling air at the breathing line and above. The air along the leaky walls was fairly comfortable, but along the tight walls, it was decidedly worse than in a window and hay chute ventilated stable.

As we have found before, it is the proper placing of adequate intakes that distributes the air in the stable and stimulates the convection currents to make possible satisfactory conditioning of the stable air.

We tried, as in former tests, to supply intake air through the windows and found again that it was unsatisfactory. The effects of the window intakes are (1) unequal distribution of air, (2) drafts, and (3) the unsatisfactory results of the human element in judging the adjustment of the window opening.

There is no question but that no matter what type of system is installed the intakes are important and necessary.

With these systems completely installed, it was possible to shift from one to the other at will, and we then operated one system through a period of normal winter weather, mild weather, and cold weather. These runs were duplicated with the other system, and, after the trend was observed, shifts from one system to the other were made during these weather conditions.

Here is what we found. During the normal winter weather of about 20 degrees (Fahrenheit), there was little difference between the two systems. For all practical purposes one was as good as the other, except when the young stock was turned out and the stable left about two-thirds full. Then the empty end of the stable became from four to six degrees cooler with the ceiling fans than with the floor fans.

There were still convection currents in the heavy stock end of the stable with the ceiling fans operating, but in the empty end without the heat from the young stock to set up convection currents, the ceiling fans seemed to remove the heat so rapidly that the long convection current swing from the stocked end to the unstocked end was retarded, allowing the air in the unstocked end to become partially stratified and chilled. During this normal winter weather period, the leaks in the walls were hardly noticed although some floor drafts did result from them.

During the cold weather, around zero or below, we secured the most marked results. With either system it was impossible to satisfactorily control conditions when the air leaks were present. The cold air would flood in especially through the leaks at the floor level, the floor drafts being objectionable and of such magnitude that diffusion was difficult.

After the leaks were stopped by papering the walls and refitting the doors, the systems then had a chance to function. The action of the ceiling fan system was as follows:

As the outdoor temperature went down from 20 degrees to zero or lower, the ceiling and floor temperatures went down, the floor temperature lowering more rapidly than the ceiling temperatures, thereby making an increasing difference between ceiling and floor. The stable temperatures kept on going down until the floor temperature was from 24 to 32 degrees, and the cold began to rise from the floor toward the ceiling. All I could think of was a great, ever-thickening blanket of cold air which, if we had not shut off the fans, might have entirely filled the stable.

With the floor fan system during a spell of the same kind of weather, the temperatures in the stable lowered much more slowly, the ceiling and floor temperatures lowering together, thereby maintaining the same difference.

There was no effect of an extremely cold floor, but rather an impression of uniform stable conditions with a very gradual cooling of the stable. And at no time did the low temperatures with the floor fans reach the low temperatures with the ceiling fans.

CEILING AND FLOOR FANS COMPARED

For the mild weather there was very little noticeable difference between the two systems.

On the whole it appears that for all weather at a temperature of 32 degrees or below, the floor fan systems are preferable, and for extreme cold periods the floor fan systems have the factor of safety that prevents the stable from freezing.

For the between-season weather, 40 to 60 degrees, it is possible that the ceiling fans may have the advantage

by their heat removal capacity. The temperatures are very much the same, but the moisture in the air seems to be slightly less noticeable — just why, I am not certain.

During the summer weather, 80 to 90 degrees, some interesting things happened. Just what would you expect to accomplish with a ventilating system in the summer? I thought it might be possible to create an air movement to obtain a lower effective temperature and overlooked the one thing the fans can do and which the natural draft system does, that is, remove odors.

On quiet days I could measure no advantage of the fans over no fans. The fact that at the time of the morning milking the stable was warmer than the outside air and at the afternoon milking the stable was cooler than the outside air, and that doors and windows were always open had something to do with this. As we have noticed before, when the stock is turned out there is practically no movement of air into or out of the stable, and the absence of convection currents produces quite a different set of conditions. There is usually some air movement or wind out-of-doors and with the stable doors and windows open, as they are sure to be in the summer, this wind or breeze effect seems to be the most practical means of ventilation.

So far as I was able to determine, no marked improvement in temperature and humidity conditions resulted from the operation of the exhaust fans in the summer season, but they are desirable as a means of removing stable odors.

Electric ventilating systems can be made just as effective as our best natural draft systems, but there is another side of the picture which must be considered by the manufacturer — an experience of last winter will serve to illustrate. We visited a stable this last winter in which had been installed a commercial electric ventilation system. Of course I could not approve of all of the details of design, but for all of that the system had many of the essentials of a good system and certainly should have functioned satisfactorily.

We happened to visit this place on a mild day, temperature above freezing. We found the doors and windows of the stable open and the system shut off; and most amazing of all, one-half the stable walls and ceiling, which were of Celotex, were wet and mouldy.

After the usual preliminaries, the superintendent told us of the entire satisfaction that the system was giving. He said that, when they chopped hay and blew it into a room adjoining the stable, the fans cleared the stable of the dust — in fact, the system worked fine.

I asked him how the system worked in cold weather, and what do you imagine he said? His answer was: "We don't use it in cold weather." Now there are others who have this same conception of ventilation to a greater or lesser degree.

You may build your system with the best of intentions, but you never know how it will be operated.

I believe that, with the electric ventilating system in farm barns, we should plan on approximately eight months' continuous operation and four months' intermittent operation. This should mean a current consumption of about 0.15 kwh per day per cow for continuous operation and about one-sixth this for the intermittent operation.

For all weather 32 degrees or below, and for all between-season weather, 32 to 60 degrees, the electric fan system should operate 24 hours a day, say, from November to April, inclusive.

In the summer they may or may not be used when the cattle are in the stable, but they should be operated during the cleaning of the stable.

The electric ventilation system has the advantage over all other systems, in that it may be more quickly installed. It costs less than the present commercial natural draft systems, and about the same as a good homemade natural draft system.

The electric ventilation system seems to be a practical and desirable system, although there are many details which remain to be perfected.

The Need for Farm House Standards[1]

By Deane G. Carter[2]

MUCH has been written of the typical, model or ideal farm home, and of the essentials of farm housing, to meet the needs of farm living. Such published material has created an impression that there may be a single standard or measure by which adequate farm housing can be judged. A more complete analysis however, shows evidence of a considerable number of factors involved in farm housing, many of which tend to break down the idea of a typical house, and which indicate the need of a wider spread in the standards suitable for the farm home.

Considerable research work has been undertaken in the fields of economics, home economics, and agricultural engineering with the objective of measuring living standards, housing requirements, and home needs. As results of such studies become available, it becomes more evident that the standards set for farm housing must cover a far wider range than has been considered necessary.

Within a limited time, it is not possible to detail all of the phases of the problem of housing standards, therefore this paper will include only a statement of the evident needs, and a proposal for setting up standards to cover this range.

The Range of Needs. Analyses of housing conditions in Arkansas indicate what has been known in a general way, that within a single state the farm population includes both white and colored; the size of farms varies from fifteen acres to several hundred acres; the operators are classed as owners, renters, managers, foremen, tenants, share croppers and day laborers; families range in size from two to ten persons; and there are extreme ranges in income, financial soundness, personal tastes and standards of living. There are variations comparable to these in every state.

Comparison with Urban Housing. This wide variation in needs and conditions on farms is quite paralleled with the range in city or industrial housing. In every city there is a range of needs from the low income level of the common laborer, through the range of the industrial worker, skilled tradesman, mechanic, clerical worker, executive, and capitalist or owner. This range in cities is quite generally recognized, and has been provided for. It has been perhaps forty years since definite efforts were first made to improve the conditions under which the poorer classes live. Building codes, housing laws, restricted areas, municipal and public utilities, and inspection and regulation have all contributed to immeasurably better conditions in cities.

During the World War period there was a notable development in industrial housing. Whole cities and suburban areas were developed, with especial regard to provision for ranges of income and living standards. Day laborers, mechanics, foremen, superintendents and executives were provided with housing facilities suited to their incomes and standards. No effort was made to make an ideal home for the low income worker, except at the ideal represented by the maximum of facilities within his income. More recently men of wealth and public spirit have developed large housing projects designed to fit the desires and the

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[1]Paper presented at the Structures Division session of the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June 1931.

[2]Professor of agricultural engineering, University of Arkansas. Mem. A.S.A.E.

incomes of the so-called middle class, and yet be within the range of their incomes.

Unquestionably the development in farm housing must be based upon some such range of facilities, closely paralleled to the ability of the farm operator to pay, and the desire for adequate housing.

Limitations in the Farm House Problem. The farm house problem is complicated, however, by a number of strictly rural conditions. In any city a change in the size, position, needs, or income of the family may be reflected in the housing standards, for by sale or rent the family may change its location quite easily. On the farm the house is usually a minor part of the whole farm investment, yet the house and the land are inseparable.

In the purchase or rental of farm property, the whole farm, rather than the house, influences the selection. There is a migratory tendency in the farm population, causing a change of location, in some sections, each three years on tenant farms, and each fifteen years in the case of owners. Should one family occupy a farm longer than fifteen years, there are changes in conditions which can be at best only partially reflected in the housing.

The net income from the farm, including the contribution to the living, is probably comparable to the wage or professional income in the city. The average income is between $1500 to $1600 a year. At this income the expenditure for housing may be about 25 per cent of the income, which would be approximately $30 a month, or a house costing $3000 total. Above and below this average income there must necessarily be an adjustment somewhat in proportion to the income.

Theoretically, there would be an infinite range of housing standards, with a special solution for each case, which is not possible and probably not necessary. Special architectural service is scarcely practical or profitable at the present time. Public service agencies like the agricultural college cannot render an architectural service. It is not desirable to adopt a standard type of construction or a standard place. So about the only practical approach seems to be to determine upon an arbitrary standard of quality that embodies, at a given cost level, a maximum of living comfort, convenience and satisfaction.

The cost range in houses is dependent upon size or volume, the quality of materials, and the equipment included. The unit or volume costs are quite uniform at a set quality of materials, for any locality. Equipment may be added as can be afforded.

The probable solution, then, is to establish four or five cost level standards as a basis for recommendation. With a knowledge of the materials and costs, each of these standards may be defined. From the basic recommendation, variations may readily be incorporated to increase or decrease the facilities.

The lowest level obviously must be at the minimum cost which will produce structural soundness, suitable area and provision for satisfactory safety, comfort, protection, and appearance. In our work at the Arkansas agricultural experiment station we have set the minimum recommendation for tenant and laborers' cottages at two, three, or four rooms, masonry base, fire-safe flue, fire-resistive roof, some form of insulating material, painted exterior and finished interior. Without mechanical or electrical equipment we can build this type for less than twelve cents per cubic foot volume.

The second standard may be made to include somewhat more area, provision for built-in equipment, bathroom space, clothes closets, enamel finishes, and similar features that permit more comfort and convenience. Thirteen to fifteen cents per cubic foot of volume has covered the cost of this type.

Perhaps a third standard could be designated as medium average, or median, having such facilities as might be expected for families at the average income level, including five to six rooms, bath, plumbing, attractive design, and selection of a higher quality of materials. Seventeen cents a cubic foot is its typical cost in Arkansas.

Fourth in the scale would be the "adequate" house — adequate in size, quality, mechanical equipment, and finish, and probably the sort of house that is usually thought of as the farm house. We can build this type of house for twenty cents per cubic foot.

A fifth standard might be considered as "adequate plus" based on higher qualities of materials, steam heat, two baths, masonry walls, brick or stone exterior and similar features. Such houses in Arkansas cost twenty-five or more cents per cubic foot.

As a rule, the demand for information and assistance comes from persons unfamiliar with the range of qualities and costs. While there is always opportunity to make variations in exterior finish, shape, and style of the house, it is particularly true that at the lower cost levels there is not a great variation in the qualities and grades of materials.

It would seem entirely possible that we might well consider "standards of housing" without any implication that a "standard house" was recommended. It is believed that a distinct service would be rendered in farm housing if a complete definition of the qualities, materials, and finishes were made as a basis for each house standard.

Tentatively it appears that about five basic standards should be set up. The cost levels will range from twelve to twenty-five cents a cubic foot, or somewhat higher in certain localities. For the lower costs at least, recommendations would be a partial substitute for special service.

Standards of rural housing need to be set up for varying standards of rural incomes

The Contribution of Agricultural Engineering to Rural Life[1]

By S. H. McCrory[2]

THE rural population of the United States, according to the 1930 census, is 53,820,000, or 43.8 per cent of the total for the nation. This rural population comprises 30,157,000 people living on farms and 23,663,000 others living in towns and villages having populations of less than 2,500.

The particular characteristic of rural life, as compared with urban residence, is the relative isolation of families, either on separate farms or in small groups, and the consequent independence and freedom of action of the members. The individuality and self-reliance engendered by rural living has been one of the great elements of our national strength. These are qualities that must be preserved.

In spite of the pressure of existing economic problems in agriculture, rural life in the United States is today on a higher plane than it ever has been before. The farmer's work is less arduous, and by his own efforts he is able to work more land. At the same time, he labors but a smaller part of the day and yet harvests bigger crops. His wife has been relieved of much of the drudgery that formerly pertained to farm life. Happily, no present-day writer can truthfully describe the wife's place on the farm in words I now quote, as published in 1539[3]:

> "It is a wive's occupation to wynowe all manner of cornes, to make malte, to washe and wrynge, to make heye, shere corne, and, in time of nede, to helpe her husbande to fyll the muckewayne or dounge carte, drive the ploughe, to loade heye, corne, and suche other. And to go or ride to the market, to sel butter, chese, mylke, egges, chekyns, capons, hennes, pygges, gese, and all manner of cornes."

Both the farmer and his family now have more leisure and more facilities for recreation and for intellectual development. What has agricultural engineering contributed to this advancement?

Agricultural engineering is not a department of fundamental science, like electrical or mechanical engineering, for instance; it is an application of available resources in power, materials, and technology to a particular field — agriculture and rural conditions. This is a broad field but fortunately characterized generally by small, independent operating units. I say fortunately, for it is to this quality of individuality that can be ascribed the rugged independence of thought and action that has been an outstanding feature of American rural life. Says an early writer[4], in reference to the self-sufficient farmer of that day:

> "From his feet to his head the farmer stood in vestment produced on his own farm. The leather of his shoes came from the hides of his own cattle. The linen and woolen that he wore were products that he raised. The farmer's wife or daughter braided and sewed the straw hat on his head. His fur cap was made from the skin of a fox he shot. The feathers of wild fowl in the bed whereon he rested his weary frame by night, were the results acquired in his shooting. The pillowcases, sheets and blankets, the comfortables, quilts and counterpanes, the towels and table cloth, were home made. His harness and lines he cut from hides grown on his farm. Everything about his ox yoke except staple and ring he made. His whip, his ox gad, his flail, axe, hoe, and fork-handle, were his own work. How little he bought, and how much he contrived to supply his wants by home manufacture would astonish this generation."

Fortunately, the farmer of today does not have to depend upon his marksmanship for his hat, nor does he cut his own harness. But it is interesting to note these evidences of self-reliance in our ancestors, and there is satisfaction in the thought that these qualities still generally inhere in our present-day farm dwellers.

Just what the future of the agricultural engineer is we do not now know. By that I mean that we do not now know how his field ultimately will develop. We are all familiar with the practicing engineers of the fundamental branches—the consulting mechanical engineer, the engineering-contracting firm, and so on. But we do not often see the shingle of the agricultural engineer displayed beside his office door. Just now we chiefly find him connected with state and federal agricultural institutions and with the larger manufacturers of agricultural equipment.

What is he doing? He is engaged either in developing new engineering facts that will aid agriculture, or in passing these facts along to the farmer. The first of these activities we call research, and the second extension. The time has not yet come when farm owners as a class will pay for engineering advice respecting their every-day operations, as will the mine owner for instance, or the mill owner. But I believe we shall see the time when the progressive farmer,—and there will be no room for any other kind,—will consider money spent for engineering advice to be well invested. Our agricultural institutions must always be responsible for training young men for this important field of work, as well as for a large part of the research directed toward developing new engineering facts applicable to agriculture. And for the present, at least, these institutions must assume practically the entire burden of instructing the farmer in respect to the engineering aspects of his operations.

Farming has generally been viewed, not so much as a business as a mode of living. Nevertheless, the quality of this living — the fullness of rural life — depends much, as in urban life, upon the profits of the business in which the members are engaged, for many of the advantages of modern life, rural or urban, depend upon services that cost money.

Engineering is not an end in itself, but is a means to an end. Consequently agricultural engineering must ever be associated closely with the other branches of agricultural research and operation, such as agronomy, entomology, plant industry, animal industry, fertilization, and perhaps most closely with farm management and agricultural economics. The agricultural engineering worker must by the very nature of his field bear in mind the necessity for cooperation.

The Land. The basis of all agriculture is the land itself. It has been said that the farmer's land is his bank. Under normal agricultural conditions he can invest money, thought, and energy in his land and reasonably hope to draw interest on his investment. This interest will include a money return, of which it is only necessary to say here that, with it, he can provide for his family the things that money will buy. But his returns will include more than money. There is something about the ownership of a well-ordered farm that appeals to the human animal. Else

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[1] An address delivered at the dedication of the Agricultural Engineering Building at the University of Kentucky, October 28, 1931.

[2] Chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

[3] Louden's Encyclopaedia of Agriculture, Vol. 1, p. 41.

[4] History of Agriculture in Northern United States, 1620-1860, p. 126.

why do we see so many wealthy city men retire to the farm. These men are in a position to enjoy all that the city offers, yet we see them desert their urban palaces to acquire land on which they proceed to lavish their money and attention. During their years of sojourn in the city, devoted to the accumulation of wealth, they carry a yearning to retire to the country. They will tell you this, and when the time comes that they feel justified in gratifying their yearning, they will proceed to do so. The truth is, I think, that in the possession of a home on a sizeable tract of land man comes nearest to fulfilling the role for which nature intended him. Now the farmer is no different than the city man in this respect, but he differs from the city man in that from the land itself he must earn his right to live on it.

Money, thought, and energy — these comprise the farmers capital that he puts in the bank, his land. Which of these is the most important? Thought, undoubtedly, for we can conceive of at least moderate success where capital and energy are limited, but we can see nothing but failure in misdirected energy and wasted funds. Now the agricultural engineer can not help the farmer in respect to the money or energy items of his capital, but fortunately he can be of assistance to him in directing the use of these resources. Through the medium of the extension engineer there are made available to the farmer the accumulated engineering experience of others, and the conclusions and results of scientific research by men who are devoting their whole time to it.

The engineering operations that concern the condition of the land as a basis for tillage are ordinarily recognized as land-clearing, drainage, and irrigation. Rather recently, the subject of soil-erosion prevention has come into the foreground, and with good reason, because we are now witnessing the slow but sure destruction of this very basis of our agriculture. Erosion is the removal of soil by rain water flowing on the land surface. The obvious remedy is to control the surface water so that it shall not erode the soil, that is, to provide proper drainage.

Just what are these engineers doing who are concerning themselves with the condition of the land? Their goal is that on every farm the land, so far as its physical condition is concerned, shall be in such shape as to yield the maximum of profit to its owner, and that this condition shall be permanent. Underdrains, where practicable, to maintain the proper balance of soil moisture and to replace the land-wasting and unsightly ditch; permanent terraces scientifically located and constructed to hold the soil on the field and conserve the rain water; stumps and stones taken off the tilled land, and field boundaries readjusted to best serve the owner's schedule of operation. These are some of the things the agricultural engineer hopes to aid the landowner in accomplishing.

In passing, I wish to dwell briefly on a specific accomplishment of the engineer in the matter of improving swamp and overflowed land. It is worth while to point out that a rough compilation shows that some 60 million acres of such land in the eastern half of our country have in the last fifty years been reclaimed from a state unfit for agriculture, either through disastrous flooding by streams or through the prevalence of malaria and today they afford homes for millions of people. A worth-while contribution, as I think you will agree.

Irrigation is not a subject of primary interest to farmers here in the East, although it is often a paying investment as a means of insuring an adequate supply of moisture at critical periods in the growth of valuable crops. In parts of the West, however, the artificial application of water plays a major part. It is essential, one may say, not only to a high plane of rural life but to the practice of agriculture at all. The vital problem of western irrigation is now, and will continue to be, the conservation of the limited water supply which means not only the capturing of every source of water but also the avoidance of waste to the last degree. It is particularly in this last feature that agricultural engineering plays an important part. The accurate measurement of water to the farmer to insure that he gets what he pays for; the best means of handling the water on his fields; the determination of the exact quantity of water he should apply to various crops to avoid waste. These are some of the ways the engineer is helping to make it possible for a considerable percentage of our population to establish and maintain homes in a section where nature, while supplying a climate and a soil of unsurpassed possibilities, has by withholding water denied us the primary means of taking full advantage of these resources.

> The agricultural engineer is helping the American farmer to make the best of the land he has; to expand his business by releasing land, buildings and energy for profit-yielding operations; to make progress which in the end can be correctly expressed only in terms of a higher plane of rural living

We still hear people speak of "worn-out" land. As a rule these lands are not worn out but washed out. In the old days the system was to abandon these lands and seek new soil. That day has passed, not perhaps so much because the American has completely outgrown his native restlessness, but rather because the day of virgin land is gone. The American farmer has come to the time when he must keep the land he has and make the best of it. And that is exactly what the agricultural engineer is helping the farmer to do — to make the best of it. Who will say that this change,—this passing from the restless era of hand-to-mouth management of land and its accompanying transitory residence to permanence with all this implies in respect to citizenship and social aspects,—who will say that this change can have other than a beneficial effect on rural life.

Mechanical Equipment. Undoubtedly the most spectacular contributions of agricultural engineering to rural life have been in the application of machinery to farming, and in the substitution of mechanical power for animal power and human labor. Just where to draw the line between mechanical technicians and engineers, I do not know, nor do I feel that it is important that such a line be drawn. Some of the agricultural machines most effective in saving human labor have been invented, at least in their original form, by men who were not technically trained in engineering. But how many of these machines are now found in their original form. The late Thomas A. Edison, we are told, in 1880 considered his carbon-filament incandescent light to be the ultimate in the way of artificial lighting.

Mechanical power on farms, in the form of windmills and steam engines, had appeared in small numbers a full half-century ago, and two decades later stationary gas engines furnished a measurable part of the primary horsepower available on farms. At that time, the beginning of the present century, mechanical power comprised probably a scant one-fourth of the total, not including passenger automobiles. In 1924, the latest year for which figures are available, work animals comprised about 42 per cent, and tractors alone 22 per cent of the total available horsepower on farms. Probably at the present time work animals constitute about one-third of the total, and tractors about the same.

The general-purpose or row-crop tractor probably has had the greatest effect in lightening the labor and reducing the cost of agricultural production. It is strictly a product

of agricultural engineering, designed on the basis of analyzed requirements for farming operations, particularly as regards weight, maneuverability, and adjustability to crop-row spacing. It provides a power unit for use by one man greater than he can control in any other form available for crop cultivation and other field operations.

With mechanical power, the saving in time required for the various farming operations reduces the amount of hired labor that must be employed, or permits increasing the acreage that can be tilled. It permits advantage to be taken of favorable soil and weather conditions for tillage, planting, and harvesting, whereby crop yields are often increased and crop losses are yet more often reduced or avoided. Mechanical power halts not for extremes of heat or cold; it requires less stable room than horses and mules; it needs not the continuous care, when idle, that work animals must have. The feed-storage space otherwise required for work stock and the fields for growing the feed, on the motorized farm can be devoted to income-producing purposes. Thus has agricultural engineering made possible an expansion of the farmer's business, without increasing his investment, by releasing land and buildings for profit-yielding operations.

I need not here recount the multitude of applications of mechanical power on the farm. Two extensively used applications, however, are the motor truck and the passenger automobile. Though not designed particularly for agricultural use, they nevertheless contribute immeasurably to economy of time in the farming business, and to the enjoyment and improvement of leisure in rural life.

Electrical power, as it is rapidly becoming more generally available, is relieving farm life, particularly in the home, of much of its drudgery. As yet, high-line service is available to but a small part of our six million farms, but through the cooperation of state agricultural colleges, federal agencies, the power interests, and manufacturers of electrical machinery and equipment, and particularly through the efforts of the Committee on the Relation of Electricity to Agriculture, the number of farms served is increasing very rapidly and gratifying progress is being made in the solution of many of the difficult problems that heretofore have operated to deprive the rural dweller of this useful agent. We can not yet say that electricity is practicable for tillage and harvesting operations, but in lighting the farmstead and the village homes, and in performing the lighter tasks of the home, the farm shop, the dairy, and the granary, it is an extraordinarily useful and convenient form of power.

Structures. Now, a few words on farm structures. It is estimated that the buildings on farms in this country today represent an investment of about 12 billions of dollars. These buildings range in age perhaps from 100 years downward. Most of them were built with no very definite idea as to what part buildings play in the economics of agriculture. We now know that the relation of farm buildings to farm profits is a very real one, although we perhaps are not able to reduce this relation to a definite figure. We can be pretty sure of one thing, though. Reasoning through analogy, that is, by considering what is being done in respect to features of other industries that represent such a huge investment, we can safely conclude, I think, that a capital of 12 billions of dollars expended in so haphazard a way as has characterized farm building expenditures, affords a real opportunity for constructive scrutiny.

> Excepting only the farm dwelling, each of the farm buildings is directly related to the farm profits and each of them must specifically be planned and built to yield the largest profit in respect to the use that is made of it

The average farmer's working life is directly devoted to securing and maintaining a home for his family. In his work he uses land, stock, implements and buildings. These, in the final analysis, are but the means to an end — the home. That being the case it is difficult to account for what we now often see in the way of farm homes. I am not advocating expensive and luxurious farm houses for I well know that this is out of the question. But I am sure that many millions have been spent on farm houses that did not yield an adequate return, simply because they were not planned wisely. It is too late, now, completely to remedy this unfortunate situation, but a great deal can be done in the way of comparatively inexpensive remodelling to mitigate the obvious results of poor planning, as well as to provide for the rural family some of the conveniences that have been developed in recent years but which so far have been available only to the city or town dweller. Here is a rich field for the agricultural engineer. I can think of no single contribution he can make to rural life which is more worth while than the helping of the rural housewife to attain these things.

As for the other buildings of the farm — the barns, the hog and poultry houses, and the storage buildings — these are tools which the farmer uses in his program of operation, and they should be considered strictly as such. By this, I mean that each type of structure has its definite purpose,—as much so as the hoe or the plow,—and each should be designed and built to meet its specific requirements. As a rule it is more difficult to arrive at these requirements than, having determined them, to design and build to meet them. In most cases the agricultural engineer must collaborate with the specialists in other fields of agriculture. A single example will suffice. Suppose we are to plan a dairy barn to recommend to dairymen in Kentucky. It has been found that the physiological reactions of the dairy cow have a direct bearing on the quality and quantity of her milk. Temperature and humidity, among other factors, to be maintained in the barn are therefore matters to be considered. Not until all of these factors have been determined and evaluated, is the agricultural engineer in a position to design the barn.

The point I wish to emphasize is that, excepting only the farm dwelling, each of the farm buildings is directly related to the farm profits and each of them must specifically be planned and built to yield the largest profit in respect to the use that is made of it.

The American Society of Agricultural Engineers has gone to some pains to formulate a very brief statement that should embody the aims and objectives of agricultural engineering education. It is this:

> "The objective of agricultural engineering education is to develop leadership by encouraging higher efficiency, greater productive capacity, and better operating practices among those engaged in the production of raw materials for food, shelter, and clothing, through the application and use of engineering principles in the industry of agriculture.
>
> "The aim of this objective is directed toward creating a desire for and the capacity to enjoy higher standards of living, better working conditions, adequate educational facilities and equitable social progress for those engaged in the agricultural industry."

I have tried to outline very briefly some of the ways in which the agricultural engineers are pursuing these aims and objectives through the application of four fundamental brancnes of engineering—civil, mechanical, electrical, and hydraulic—to the everyday operations on the farm. The field is very wide. We have as yet made no more than a start. I am sure, however, that the agricultural engineer has already made himself felt as a factor for agricultural progress, which progress in the end can be correctly expressed only in terms of a higher plane of rural living.

Size of Rooms in Five-Room Houses[1]

By Dan Scoates[2]

IN THE first article of this series[3] it was pointed out that the five-room house was the most popular size for the southern farm home. As a result of this fact, we decided first of all to make a study of this size house. In doing this, we tried to analyze these houses into their various parts, and to study each part. The first thing that seemed desirable to do was to determine the sizes of the various rooms, and so this was done from the standpoint of their dimensions in feet. One hundred floor plans of five-room houses now in use in various sections of the entire South were studied. The accompanying graphs give the results, and can be read directly in percentages as well as in number of homes.

What we were trying to find out was just what the conditions were in the farm homes in use at the present time. We do not hold that the houses studied were necessarily perfect or ideal, but it seemed to us that they would show the present conditions, and it was desirable to know conditions existing in the farm homes now being used.

Kitchen. In Fig. 1 are shown the various sizes of kitchens that were found to be the most popular. There were seven different sizes varying from 10x12 feet to 14x16 feet. There were a number of other sizes used which are not tabulated here and which were not so popular as the ones shown. This graph shows clearly that the two sizes most popular were 10x12 and 12x14 feet.

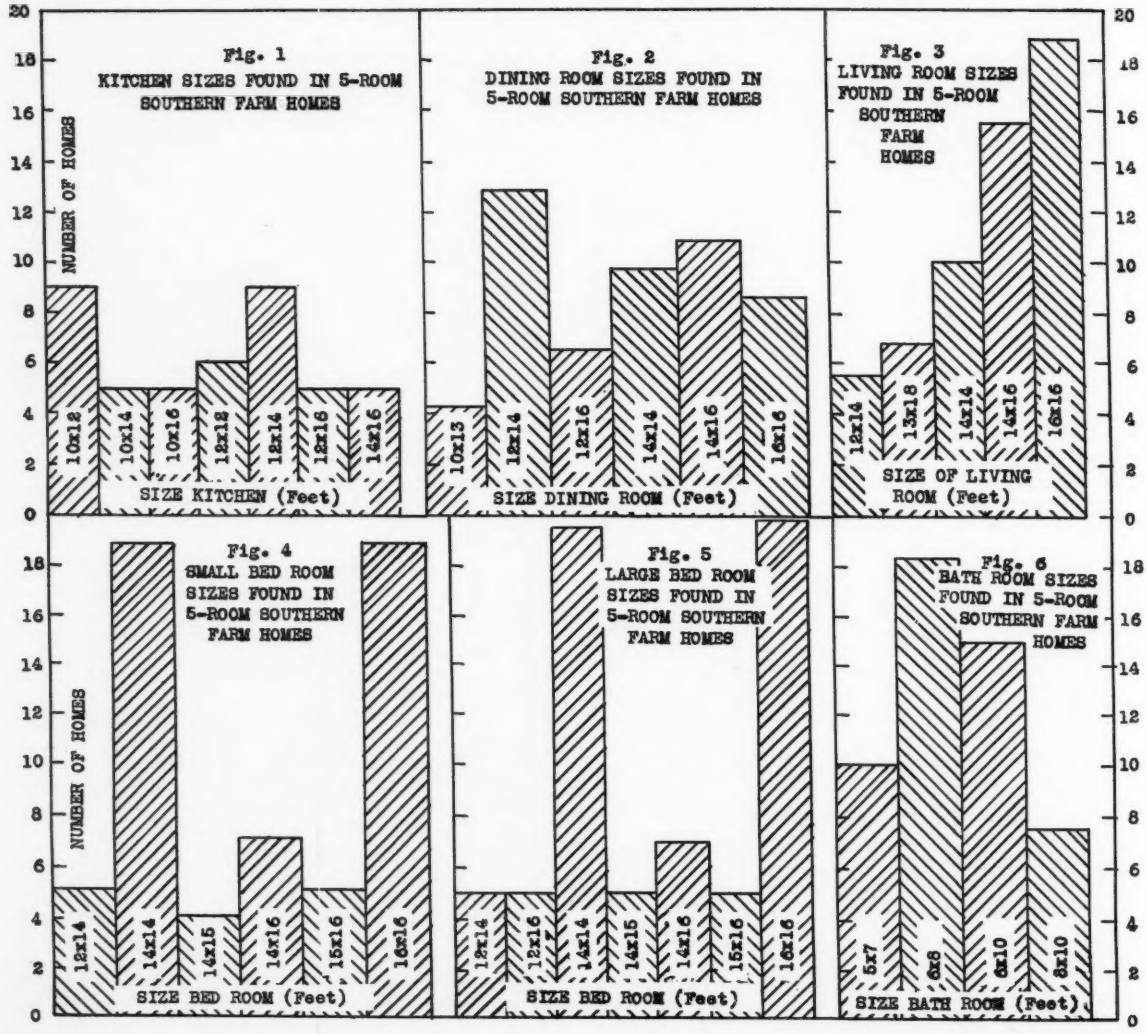
Dining Room. The most popular sizes of dining room are shown in Fig. 2. The 12x14-foot size was used most with the 14x16-foot size coming second.

Living Room. The living room sizes which predominated are shown in Fig. 3. This shows that the 16x16-foot living room was the most popular. Those who have studied sizes and shapes for living rooms, will agree that a rectangular

[1]Second of a series of articles presenting the results of an engineering investigation of farm house sizes and design.

[2]Professor of agricultural engineering, A. & M. College of Texas. Mem. A.S.A.E.

[3]AGRICULTURAL ENGINEERING, Vol. 12, No. 10 (October 1931), page 384.



room for this purpose is much more satisfactory than a square room. The living room used most in these houses was square. It will be noticed that all through the sizes for each kind of room that the 16x16-foot size was popular. In fact, it is found on four of the six graphs. This probably can be explained by the fact that a very common southern farm home plan consists of four square rooms, usually 16x16 feet. These four rooms are divided into sets of two by a wide open hall ranging from 8 to 10 feet in width. Then there is a back and front porch. Some of these plans, of course, have been rearranged to a certain extent either by having another room added, or by having the hall enclosed, or two of the rooms on one side made into three. The result of it all is that the 16x16-foot room is still found in a good many farm houses in the South.

Bed Room. It was thought when this study was made that, in the five-room houses, it would be found that there were two different size bed rooms, a large one and a small one. These plans were analyzed on that basis and so in setting up graphs of the results, there are two for bed rooms, one for the small bed room (Fig. 4) and one for the large bed room (Fig. 5). A careful study of these graphs will show that there is little difference in the sizes of bed rooms, and that the 14x14 and 16x16-foot sizes predominate. These are large bed rooms, as bed rooms go, which indicates that the room sizes in the South, particularly with reference to bed rooms, will probably run larger than in other parts of the country.

The sizes found for bath rooms are shown in Fig. 6. Nowhere near all the houses have bath rooms, but it is interesting to note that the 6x8-foot size is the most popular. This is a popular size in all houses, city or country. It is the last room to be added to the farm house, and in all probability its size has been taken directly from that used by those living in the cities.

No attempt was made to find size or shape of porches, closets, or halls. The study thus far has dealt with the major rooms such as have been discussed.

Heating and Ventilating Sweet Potato Storage Houses[1]

By H. E. Lacy[2]

PROPER conditions for curing and storing sweet potatoes successfully have been known for some time. At the Georgia State College of Agriculture during the past four or five years methods of controlling such conditions have been studied by testing the various heating systems that would probably be used in the potato house. Results as to uniformity of heat distribution, uniformity of evaporation and economy of fuel consumption have been compared. These conditions should be maintained, with little draft regulation, in order to relieve the operator of responsibility.

There are several types of heating systems that can be used for heating sweet potato houses, including the stove above the floor, the stove below the floor, or the furnace and flue as used to cure tobacco. There are also different types of ventilating systems that may be used.

In conducting the experiment the first year no sweet potatoes were used in the test, as it was thought best to run five preliminary tests for comparative purposes before the actual curing tests were conducted. Only one curing test could be made each year, but by using wicks saturated in water we were able to investigate the heating and ventilating characteristics of six designs of natural draft houses, in one house in five months. One of these tests was on a type of design in common use, while the others were special designs to enable us to study the results to be expected from certain features of design. These main features included (1) two types of ceiling, flat and sloping; (2) two types of exhaust ventilators, Rutherford and King; (3) two positions of the stove, above and below the floor; (4) two methods of intake, cold and heated; and (5) two methods of circulation, natural convection and distribution by pipe.

From the results of these tests a house was selected which had a sloping ceiling, heated intake, stove below the floor, distributed heat and Rutherford type vents as the experimental house for the first test in which potatoes were actually cured. This was in 1927. In 1928 a similar test was made in the same house with a tobacco heating furnace and flue in place of the stove below the floor, and in 1930 a third test was made, the only change being the addition of several inlet vents to fit the house for a better distribution of the incoming air.

The description of a house using natural ventilation which has been found suitable for curing sweet potatoes, and which was used in the last three tests, follows.

This house is of wood, the studding being of 2 x 4 material set on the sills. On the outside of the studding 1 x 6 boards were nailed diagonally to brace the wall, with a layer of heavy building paper over these and a layer of matched siding over the paper. The inside was treated the same way making walls which were of four thicknesses of boards and two of building paper, with an air space between. The tighter the walls the less difficulty is encountered in controlling the temperature and moisture in the storage house. The roof construction was handled the same as the walls, except that roofing material was added to protect the house from rain.

A space, sufficiently wide through the center of the house to allow the operator to store or remove potatoes with ease, was floored with two layers of boards with building paper between them. The remaining floor area had 2 x 4 pieces laid on the joists with no flooring so as to allow free circulation of air through this part of the floor space. The crates were packed directly upon the 2 x 4 pieces as close together as possible so the air as it was heated had to rise through the crates, and in doing so evaporate and carry away moisture from the potatoes.

Only one inlet ventilator was used with the stove below the floor for distributing the heat. It delivered the incoming air directly to the stove where it was heated and distributed throughout the house. This method worked satisfactorily for this type of heating system, but for the tobacco flue it is best to have the intake ventilators located at various points in the wall at a lower level than the flue. This aids in getting a more uniform temperature and evaporation in all parts of the house.

In the test conducted during 1927 the stove was below the floor with the inlet ventilator delivering all the air directly to the stove which was surrounded by an air jacket. The heated air passed upward and entered pipes which distributed it along under the potatoes. The temperature was recorded at heights of 2, 5 and 8 feet. The average temperature at the 2-foot level was 75.2 degrees (Fahrenheit), while at the 8-foot height it was 80 degrees, or a difference of 4.8 degrees. The temperature difference was even less in 1928 and 1930, when the tobacco curing

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[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at Atlanta, Ga., February 1931.

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Table Showing Average Performance Records in Nine Tests

Test No.	Outside Temperature, degrees	Humidity per cent	Temperature above floor, degrees			Humidity above floor		Moisture removed per lb. air, grains	Velocity of air, ft. per min.	Fuel, lb. per day
			2 ft.	5 ft.	8 ft.	2 ft.	8 ft.			
1927	58.2	56.7	75.2	78.8	80.0	35.4	34.5	12	137.2	
1928	60.3	59.5	73.3	77.5	78.4	54.4	43.5	57.5	90	141
1930	57.2	54.8	75.7	76.7	77.7	41.5	40.5			120
1	71.4	52.4	82.3	83.5	84.8	57.5	53.5	37	56	
2	66.5	58.6	77.0	81.7	92.0	68.3	56.6	46	65.7	61
3	73.0	48.0	75.7	78.5	95.5	62.5	53.0	98	159	52
4	80.3	47.0	79.2	81.5	89.6	66.5	62.3	60	168	86
5	80.5	55.7	84.5	85.8	94.5	76.4	59.6	48	46.2	42
6	73.4	66.2	84.5	86.2	89.4	63.8	58.0	38	142	61

flue was used. In some of the preliminary tests the difference in temperature was as much as 18 degrees. This indicates that the combination we have selected is satisfactory in regulating temperature at various heights in the building. This fact is further verified by noting the evaporation or loss in weight of potatoes at various heights. There was a fraction of a pound more loss in the bottom row than in the top row, while all the other rows were practically the same.

One difficulty was found in heating with the tobacco furnace. As would be expected the furnace end of the house was somewhat hotter than the opposite end, especially when the furnace was placed on the inside of the building with the door opening on the outside and flush with the wall. The furnace end was found to be from 3 to 7 degrees, hotter than the opposite end, and the potatoes were dried a little more than the others. In the 1930 test this was almost eliminated by the change we made in the ventilators. It could be further helped by placing the furnace entirely on the outside of the house and giving the flue the correct elevation so that the heat would be drawn to the opposite end of the building. The opposite end of the flue from the furnace should be a little higher with a gentle slope all the way. The correct amount can best be determined by experience, but should be about one inch in six feet.

Something should be said about the economy of fuel in the different houses. It is difficult to make direct comparisons in each test because of the fact that the outside temperatures were different in each case, and since a temperature of just below 80 degrees was kept on the inside. The tests of 1928 and 1930 show that it takes about one pound of coal to cure each bushel of potatoes in the 16 by 32-foot house. As the furnace we used has capacity enough to furnish heat for a house three times this size, it would seem that this type of heating system is very economical in use of fuel. The stove below the floor used slightly less coal than did the furnace.

An interesting thing happened to the potatoes in the test house in 1930. It so happened that there were three lots of potatoes stored in this house that were grown in different fields. Although these potatoes were dug and stored in the same house they did not show the same keeping qualities. One lot grown on a piece of land from which several houses had been moved, developed the disease of soft rot just a few days after being dug, even before they had been cured. Another lot was attacked by black rot, and the other by neither the black rot nor the soft rot. This brings out the fact that curing has very little to do with these diseases attacking the potatoes, and that if disease-free potatoes are stored they will be much easier to keep. However, by keeping the proper temperature and humidity in the house, the spread of the disease can be checked considerably. In the natural-draft house the proper temperature and humidity can be obtained during the storage period simply by the use of the door and ventilators.

If the temperature falls below 50 or 55 degrees, it can be raised by opening the door and ventilators on a warm, dry day until the proper conditions are obtained. To lower the temperature it would only be necessary to open on a cool day or night. By this method it is rarely ever necessary to build a fire to raise the temperature. This is true for houses in Georgia, although it may be necessary to do otherwise in the states farther north. When using this method it is best not to allow too much air to pass through the building since it may cause the potatoes to lose much weight during the storage period, and the grower will find that his potatoes are too dry when he puts them on the market.

A few conclusions from the preliminary tests supported by the graphs of results are as follows:

1. Shortening the draft ducts to the minimum, thus reducing friction, gives most effective evaporation.
2. The admission of large amounts of unheated air is highly effective in causing evaporation.
3. The two conditions just mentioned are conducive to the highest fuel economy.
4. Sloping ceilings increasing the effective height above the top layer of crates and tending to streamline the exhaust currents to vents in the ridge, are conducive to greater uniformity in temperature throughout the storage space than are flat ceilings.
5. The most uniform temperatures are obtained with distributed heat.
6. Uniformity of temperature characteristics is accompanied by uniformity of relative humidity and uniformity of the evaporative and curing rates through the storage space.

The actual curing tests of 1927, 1928, and 1930 all verify these conclusions, and we feel that we can rely on the data obtained in these tests in designing a sweet-potato curing house that will possess the requirements needed to insure uniform heat distribution, uniform evaporation and economy of fuel consumption to the extent that should be expected in a successful curing house.

DESCRIPTION OF TESTS

1927 Test. The house was left as for No. 6, but with better installation about the entire building, including the foundation wall.

1928 Test. The house was left as for No. 6, with the exception that a tobacco-curing furnace was used instead of the stove below the floor.

1930 Test. Same as the 1927 test, with a change in the inlet ventilators doing away with the old ventilators and putting in ten small ones, two in each end and three in each side to bring the air in below the flue.

The test number referred to in the table applies to the following combinations of variable features of storage house designs:

Test 1. Flat ceiling, heated intake, stove below floor, distributed heat, King type vents

Test 2. Flat ceiling, heated intake, stove below floor, central heat, King type vents

Test 3. Flat ceiling, part of intake heated, stove above floor, Rutherford type vents

Test 4. Standard type check. Sloping ceilings, part of intake heated, stove above floor, Rutherford type vents

Test 5. Sloping ceiling, part of intake heated, stove above floor, King type vents

Test 6. A proposed improvement in design. Sloping ceiling, heated intake, stove below floor, distributed heat, Rutherford type vents.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

[Agricultural Engineering Investigations at the Kansas Station] (Kansas Station (Manhattan) Biennial Report 1929-30, pp. 50-52, 136, 137, 142).—It is reported that the wheat combine is very well adapted for the harvesting and threshing of suitable varieties of sorghum. The necessary adjustments are easily made and require very little expenditure of money and labor. Many of the 18 varieties of sorghums tried out proved to be poorly adapted for combining. The most important characteristic of sorghums in combining is their ability to stand up in all kinds of weather and until late in the winter. From the threshing standpoint, the necessity of taking considerable stalk and leaves in order to get all of the heads does not seem to be objectionable. Two men with the harvesting unit and one with a truck harvested as much as 200 bushels per hour at a cost of about 62 cents per acre.

The safe storage of combined sorghums presents a more difficult problem than harvesting and threshing. Sorghums containing 16 per cent moisture were safely stored in a well-ventilated steel bin from December to April. Sorghums having an average moisture content of 19.4 per cent were badly molded and damaged in the bottom of a tight wooden bin after being stored until February 18. Moving the grain did not materially improve the condition.

The progress results of studies of combined wheat storage are presented, which have been noted below from another source (Agri. Engin. See article by F. C. Fenton and C. O. Swanson (Cereal Chem. 7 (1930), No. 5) attached).

Comparative tests of cooking equipment showed that for gas stoves the efficiencies, lengths of time, and amounts of fuel vary with the gas pressures used and the rates at which the gas is burned.

In feed grinding studies the most important single factor affecting the energy requirements of ensilage cutters was the speed at which the elevator fan was operated. If the speed was excessive, energy was wasted in overcoming air friction. Increasing the speed increased the capacity, but the power requirement was increased more rapidly. From 400 to 550 rpm, if maintained, was sufficient to operate any of the cutters while elevating into a 40-foot silo. The energy for cutting kafir silage into 0.25-inch lengths increased approximately one per cent for every ton load that passed through the cutter, due to the gradual dulling of the knives. The power consumption was from 35 to 60 per cent greater for dull knives than for sharp ones, depending upon the material cut. The capacities of the cutters varied from 5 to 15 tons per hour when using a 10-hp motor, depending upon the condition of the material and the length of cut. The capacity for a 0.5-inch cut was approximately 35 per cent greater than for a 0.25-inch cut.

Studies on the Qualities of Combined Wheats as Affected by Type of Bin, Moisture, and Temperature Conditions, I., F. C. Fenton and C. O. Swanson (Cereal Chemistry (St. Paul), 7 (1930), No. 5, pp. 428-448).—The progress results of studies conducted by the Kansas Experiment Station in cooperation with the U. S. D. A. Bureaus of Agricultural Economics and Plant Industry are reported.

Eleven bins, each of approximately 500-bushel capacity, were used, which were previously described (Agr. Engin., 11, pp. 247-249).

It was assumed that a temperature of 45 C was dangerous, and whenever the wheat reached this temperature it was moved and thus cooled. The blower elevator was the more effective in cooling, but the amount of cooling also depended on the outdoor temperature. Wheat moved on hot days was cooled very little, while on cool days a decided cooling was effected.

The grain in Bin 1 kept in perfect condition, and that in Bin 2 overheated quickly and was moved. According to the baking test, all samples from this bin had suffered damage, some more than others, but those taken at the second moving had suffered the least. On the whole, it can not be said that wheat in Bin 3 had suffered any damage which would seriously lower its milling and baking values. The low germination and the fairly high rancidity in some of the samples showed that this wheat had, in part, suffered some deterioration. All the samples from Bins 4 and 5 graded "no damage," and, except for one sample, the rancidity tests were low. The baking results also did not indicate any damage.

The wheat in Bin 6 kept very well on the whole and that in Bin 7 even better. In germination, rancidity and baking tests, the wheat from Bin 9 was quite similar to that from Bin 2. The wheat was practically all dead, the rancidity, except in one sample, very high, and the baking tests, except in a few cases, showed poor results. The wheat in Bin 11 was dead in most of the samples, and the rancidity was high except in three samples. In these two respects the wheat was quite similar to that in Bins 2 and 9, but the baking results indicated somewhat less damage, showing that the wheat in Bin 11 had not suffered so much damage on the whole as that in Bins 2 and 9.

Ventilating flues placed vertically in the wheat were apparently of no value. They seemed to be more harmful than beneficial, since there was usually an area of excessively damp wheat around these ventilators. The same was true of the small central ventilators furnished with some of the steel bins.

Moving wheat to prevent serious or total damage seemed to be quite effective. Based upon the movement of 16 bins of wheat, it appeared that the wheat can be cooled two-thirds of the difference between the wheat temperature and the outside air temperature.

The Estimation of Free Calcium Hydroxide in Set Cements.—A Calorimetric Method, G. E. Bessey ([Great Britain] Department of Science and Industrial Research (London), Building Research, Technical Paper 9 (1930), pp. IV + 25, figs. 5).—This paper deals with the development and application of a new calorimetric method for the estimation of free calcium hydroxide in fresh and set cements. The method consists of two simple determinations of heat of hydration of samples ignited at two different temperatures. Tests showed that the method gives satisfactory, reproducible, and reasonably accurate results with hydrated portland cements.

Husker-Shredders in Corn-Borer Control, I. F. Reed and W. R. Humphries (U. S. Department of Agriculture, Farmers' Bulletin 1662 (1931), pp. II — 17, figs. 17).—This bulletin is based on tests conducted on husker-shredders. It describes the operation of the machines and makes suggestions as to their operation and care, with special reference to corn-borer control.

It has been found that, with proper adjustment and careful operation, husker-shredders kill from 95 to 98 per cent of the borers in the stalks. Most of the borers are killed while passing through the snapping rolls. Shredder heads, combination heads, and knife heads cutting 2 inches or less are about equally effective in destroying corn borers. The greatest number of borers are killed when fodder is cut into 0.5-inch lengths and the least number when the fodder is cut into 4-inch lengths. Live borers in the stored fodder in excess of 2 per cent may become a source of increased infestation.

Influences Affecting the Life of Fence Wire and Methods for Preventing Its Corrosion, W. C. Pruett, et al (Bulletin of American Railway Engineering Association (Chicago), 32 (1930), No. 330, pp. 172-174).—The results of experiments are briefly summarized which indicate that zinc is the most suitable protective coating for wire, the protection afforded being determined by the amount of zinc coating per square foot of surface treated. The galvanizing on barbs of barbed wire and the stays and wraps of woven wire is usually the first to fail.

The use of corrosion-resisting steel for the base in wire is almost equal to, if not better than, a good coating of galvanizing. The annealing treatment produces an iron-zinc alloy which has proven by tests to provide a longer life to coating with the resultant longer period of galvanizing protection to the steel base against ordinary corrosion. The damaging effect to the zinc coating on wire, resulting from the burning of vegetation under and about the wire, was found to be very pronounced.

Studies in Reinforced Concrete. — I, Bond Resistance, W. H. Glanville ([Great Britain] Department of Science and Industrial Research (London) Building Research, Technical Paper 10 (1930), pp. VI + 37, pl. 1, figs. 17).—Experiments to determine the influence of the length of embeddment and the stress in a bar on the bond resistance between steel and concrete are reported, and a new theory of the distribution of bond stress is developed.

The distribution of bond stress at failure is shown to depend closely on the radial movement of the bar under load and therefore on the stress in the bar, and to be independent of the initial shrinkage stress distribution along a bar. The relation between the bond stress distribution and the length of embeddment is independent of the diameter of the bar. For a working stress of 16,000 pounds per square inch the usual allowance of 40 diameters for length of embeddment provides a reasonable factor of safety.

Studies in Reinforced Concrete.—II, Shrinkage Stresses, W. H. Glanville ([Great Britain] Department of Science and Industrial Research (London) Building Research, Technical Paper 11 (1930), pp. VI + 49. pls. 2, figs. 16).—The results of experiments to determine the distribution of shrinkage stress along a reinforcing bar are reported and approximate methods outlined for

allowing for the creep occurring during shrinkage in making calculations for shrinkage stresses.

It was found that "the shrinkage stress distribution along a reinforcing bar is such that, proceeding from the end of the bar toward the center, a gradually increasing compressive stress is developed in the bar by a practically uniform bond stress over a length which is short compared with the usual length of reinforced concrete members, depends on the diameter of the bar, and is usually not greater than about one foot. Over the remaining central portion there is no bond stress and the steel stress is uniform. The length over which bond stresses are developed at the ends does not depend appreciably on the age of the concrete.

"During the development of shrinkage stresses, creep or flow of the concrete is taking place continuously. The amount of this creep is of the same order as the elastic movement, the exact value depending on the cement employed in the concrete. In calculating the shrinkage stresses in reinforced concrete it is possible to allow approximately for the creep in the concrete by using a fictitious or 'effective' value of the modulus of elasticity of concrete. This effective modulus of elasticity varies for the different mixes tested between 3.0×10^6 and 1.5×10^6 pounds per square inch, corresponding to modular ratios of 10 and 20. The values do not vary with the percentage of steel used or appreciably with the age of the concrete up to at least 6 months old, the maximum age for which it has been possible to make calculations.

"To a reasonable approximation, the following formula may be used for calculation of the steel strain due to shrinkage of the concrete in a symmetrically reinforced member:

$$e_s = \frac{s}{\frac{E_s\, a_s}{E_c'\, a_c} + 1}$$

in which E_c' is the effective modulus of elasticity (allowing for creep) s is the concrete shrinkage and a_s and a_c are the areas of the steel and concrete. No serious error will arise if this is taken as 2×10^6 pounds per square inch for all ages." It is demonstrated that some end distortion takes place in reinforced concrete members.

Studies in Reinforced Concrete.—III, The Creep or Flow of Concrete Under Load, W. H. Glanville ([Great Britain] Department of Science and Industrial Research (London) Building Research, Technical Paper 12 (1930), pp. VI + 39, pls. 6, figs. 23).—Studies are reported the results of which indicate that when a plain concrete specimen is maintained under load at constant temperature and humidity, the three factors which produce alterations in length are creep under load, shrinkage, and change in modulus of elasticity.

It is demonstrated that during loading the relation between stress and strain, for concretes of the types tested, departs from direct proportionality by an amount depending on the creep taking place, and therefore on the rate of loading. The true modulus of elasticity is that which would theoretically be obtained with instantaneous loading.

The creep over long periods is shown to be practically proportional to the applied stress within the range of working stresses, and the magnitude of the creep depends on the type of cement used. The more rapid the hardening of the cement, the smaller is the creep for a given age, provided the concrete is stored in air. The creep is also approximately proportional to the quantity of aggregate used. Normal portland, rapid-hardening portland, and aluminous cements showed very similar general properties in this respect.

The creep is considerably lower for specimens of portland cement concrete maintained wet than for similar specimens stored in air, whereas aluminous cement showed the reverse effect.

For reinforced concrete calculations the reduced modulus of elasticity can not be used except as a rough guide. More exact formulas for columns are developed, and it is shown that the use of a reduced modulus of elasticity leads to a value of the increase in steel stress due to creep which may be more than 20 per cent less than the actual increase.

The Effect of Under-Stressing on Cast Iron and Open-Hearth Iron, J. B. Kommers (American Society of Testing Materials (Philadelphia) Proceedings, 30 (1930, pt. 2, pp. 368-381, figs. 3).—Tests conducted at the University of Wisconsin of gray cast iron and open-hearth iron representing, respectively, nonhomogeneous and homogeneous metals are reported.

The more homogeneous open-hearth iron seemed to be susceptible of a less percentage of strengthening than the nonhomogeneous cast iron—about 10 per cent as compared to a maximum of 31 per cent for cast iron. The results of fatigue and understressing tests on notched specimens are also presented, and the contrasting phenomena observed for open-hearth iron and cast iron are explained.

Elastic Behavior of Spring Materials, M. F. Sayre (American Society of Testing Materials (Philadelphia) Proceedings, 30 (1930). pt. 2, pp. 546-558, figs. 6).—This paper reports the results of tests on spring steels and phosphor bronze and also on hard-drawn aluminum alloy wire. These indicate that the elastic limit and the proportional limit do not coincide, and that the true stress-strain line, aside from any plastic flow or hysteresis effects, is curved throughout. Definite quantitative values for the rate of change of modulus of elasticity with stress intensity are given. Figures are also given which indicate, for certain steel specimens, a marked increase in hysteresis and decrease in modulus of elasticity as a result of temporary overstressing beyond the elastic limit.

Procedure Used by the Forest Products Laboratory for Evaluating Paint Service on Wood, F. L. Browne (American Society of Testing Materials (Philadelphia) Proceedings, 30 (1930), pt. 2, pp. 852-870, figs. 5).—This paper, contributed from the U.S.D.A. Forest Products Laboratory, describes the procedure used by the laboratory for evaluating paint service on wood. Evaluation of paint service in paint tests involves three steps, namely, description of the changes that take place in the coatings during exposure, rating the extent of the changes, and interpretation of their significance in terms of the practical serviceableness of the coatings.

Hiding Power Measurements in Theory and Application, A. H. Pfund (American Society of Testing Materials (Philadelphia) Proceedings, 30 (1930), pt. 2, pp. 878-883, figs. 2).—In a contribution from John Hopkins University, tentative definitions for hiding, hiding power of paint, and hiding power of a pigment are presented. A new "Black-and-white" cryptometer, based on the above definitions, is described and the usefulness of this instrument for measuring the wet hiding powers for all types and colors of coatings is demonstrated. A precision cryptometer, involving the use of a photoelectric cell in place of the human eye, has been developed. This device, which is extremely sensitive and free from the subjective errors of the human eye, yields precision results of hiding power.

A Practical Brush-Out Test for Hiding Power of Paints, H. A. Gardner, G. G. Sward, and S. A. Levy (American Society of Testing Materials (Philadelphia) Proceedings, 30 (1930), pt. 2, pp. 891-894, fig. 1).—This paper deals with a practical method of determining hiding power by actually brushing out a paint upon a surface of checkerboard linoleum made up of black and white blocks. The results obtained by this method are compared with results obtained by the Pfund cryptometer, and it is found that the brush-out method gives higher results. The results, however, retain the same order of magnitude.

Investigation of the Effect of Phosphorus in Wrought Iron, J. H. Higgins (American Society of Testing Materials (Philadelphia) Proceedings, 30 (1930), pt. 1, pp. 170-184, figs. 6).—The results of an extensive series of tests of the effect of phosphorus in wrought iron are reported. These indicate that tensile strength and yield point are increased, and that the elongation and reduction of area are decreased with an increase in the phosphorus content. The vibratory tests also show an increase in vibrations before failure as the phosphorus increases.

Resistance of Concrete and Concrete Pipes to Corrosion by Water [trans. title], R. V. Frost and E. J:son Virgin (Statens Provningsanst., Stockholm, Meddel. 48 (1929), pp. 64, figs. 16 Eng. abs., pp. 62-64).—Laboratory tests using the percolation method are reported, with special reference to the influence of carbon dioxide in the water on concrete of different mixtures.

It was found that pure water has a relatively great dissolving power, while water containing bicarbonates of lime and magnesia (temporary hardness) are less aggressive. If the surface of the cement has been previously carbonated this diminishes the release of lime, especially in the case of water with no or only a low temporary hardness. The existence of aggressive carbonic acid, which is common in subsoil water in Sweden, enhances the dissolving power of the water, and a content of from 30 to 50 milligrams per liter is considered dangerous to unprotected concrete. If the water only affects the surface of the concrete, and the latter is so tight as to prevent water from entering it, the attack of the water is as a rule very slow; and for practical purposes a perfectly tight concrete has a good and sufficient durability in ordinary river and lake water and subsoil waters that are not too aggressive. Carbonation of the concrete surface in the open air with repeated damping with water increases, as a rule, its endurance against the action of water.

Power and Heat in Agriculture and in Agricultural Industrial Management, W. Leder (Kraft und Warme in der Landwirtschaft und in Landwirtschaftlich-Industriellen Betrieben. Dresden and Leipzig: Theodor Steinkopff, 1930, pp. X + 222, figs. 145).—This book contains chapters on fundamental principles of power and heat and their technical application, power and heat in the dairy, drying and processing of agricultural products, power and heat utilization in ceramics, peat development, and fuel manufacture.

Plows and Plowing, J. M. Smith (Alberta University (Edmonton), College of Agriculture Bulletin 6, 4, ed., rev. (1930), pp. 42 + [3], pls. 5, figs. 23).—This is the fourth revised edition of this bulletin. It contains practical information on the adjustment and operation of plows.

Land Drainage and Flood Protection, B. A. Etcheverry (New York and London: McGraw-Hill Book Co., 1931, pp. X + 327, figs. 141).—This work deals with the surface drainage and under-

drainage of agricultural lands affected by excessive water due to precipitation or irrigation, the protection of lands against flood and tide waters, and the methods of spreading assessments for the apportionment of the cost of the several classes of improvements to the areas benefited. It emphasizes fundamental theories and principles of design, and has been planned to be useful to engineers interested in land drainage and the protection of overflow lands, also to trustees, directors, or other officials of reclamation and drainage districts, and to commissioners of assessment.

The first eight chapters deal mainly with the surface and underdrainage of lands in which the need for drainage results from excessive precipitation or lack of natural drainage. In this connection, emphasis is placed on soil formation, soil texture, and soil water and their relation to drainage; the theory and principles of soil drainage; the relation of surface drainage to underdrainage and the fact that artificial drainage is supplemental to natural drainage; the design of open drainage and underdrainage systems; drainage of lands with variable conditions of soils and subsoils as well as that of lands with uniform soil texture and structure; and the construction and maintenance of tile drain systems. The remaining chapters deal with drainage of water-logged irrigated lands, protection of lands from flood waters, problems in the computation of flow in river channels, reclamation of tidal lands, and drainage and reclamation districts.

Agricultural Power Handbook ([San Francisco]: Pacific Coast Electric Association, 1929, pp. 62, figs. 35).—This handbook attempts to cover the major uses of electricity in the agriculture of the Pacific coast region.

Flow in Silt-Laden Canal Gaged by Contracted Flume, R. L. Parshall (Engineering News-Record (New York), 106 (1931), No. 5, pp. 183-185, figs. 3).—In a contribution from the Colorado Experiment Station and the U.S.D.A. Bureau of Public Roads, a description is given of a large Venturi flume installation in the Fort Lyon irrigation canal near La Junta, Colo., which has a capacity of about 1,800 second-feet and serves an area of 96,000 acres. Comparison of observed and computed discharges for flows from 128 to 1,464 second-feet shows a maximum deviation of 2.3 per cent.

A Practical Venturi Meter for Irrigation Service, J. E. Christiansen and I. H. Tellman (Engineering News-Record (New York) 106 (1931), No. 5, pp. 187, 188, figs. 3).—In a contribution partly from the California Experiment Station, a description is given of an installation of Venturi meters in the Consolidated Irrigation District near Fresno, California. The meters are built of precast concrete tubes and range in size from 16 to 42 inches. They consist of three sections to form the tube and a vertical well for measuring heads. Beginning at the upstream end, the parts of the meter consist of (1) a short entrance section of uniform diameter containing the entrance pressure connections, (2) the combined entrance cone and throat sections with the throat piezometer ring, and (3) the exit cone of gradual taper providing a return to the original diameter. The discharge end of the meter consists of a concrete head gate which is constructed as part of the device. The piezometer rings, both at entrance and throat, consist of ½ or ¾-inch iron pipes embedded in the wall of the section with four or five equally spaced ⅜-inch holes drilled through the concrete to the inside of the tube.

The results of discharge coefficient determinations are also presented.

Reinforced Brick Reservoirs, E. J. van Meerten (Union South Africa Department of Agriculture (Pretoria) Bulletin 79 (1929), pp. 43, figs. 28).—Detailed information is given on the design and construction of reinforced brick reservoirs for farm water supplies in South Africa.

A Reinforced Concrete Reservoir, E. J. van Meerten (Union South Africa Department of Agriculture (Pretoria) Bulletin 66 (1929), pp. 15, figs. 10).—Brief information is given on the design and construction of a reinforced concrete reservoir for farm water supplies in South Africa.

Refrigeration as Applied to the Transportation and Storage of Food Products, E. W. Shanahan (London: Gee & Co., [1929], pp. X — 96, figs. 4).—This book deals with the technical and practical phases of refrigeration. It contains chapters on refrigeration as a factor in the food supplies of great cities and densely populated areas, the genesis and growth of refrigeration, the volume and the nature of refrigerated traffic, the technical basis of mechanical refrigeration, insulation and insulating materials—design of cold stores and refrigerated rolling stock, the treatment of produce under refrigeration, defectiveness of final links in cold storage chains, and refrigeration in relation to present and future food supply services.

A Further Memorandum on the Draining of Hilly Lands with a View to Reducing Soil Erosion, E. O. Felsinger (Tropical Agriculture ([Ceylon], 74 (1930), No. 2, pp. 68-70, pls. 6).—Methods of draining and terracing hill lands planted to rubber to prevent erosion are described and diagrammatically illustrated.

Making Rapid Field Examinations of Flood-Control Reservoir Sites, J. A. Holmes (Engineering News-Record, 106 (1931), No. 10, pp. 386-388, figs. 4).—Methods used to secure physical and economic data on 14 dams and 6 river systems in the Mississippi River valley are described.

Production of Gasoline and Lubricants by Hydrogenation, R. T. Haslan and W. C. Bauer (S.A.E. [Society of Automotive Engineers] (New York) Journal, 28 (1931), No. 3, pp. 307-314, figs. 10).—A brief description of the hydrogenation process and its three characteristic reactions, purification, stabilization, and homogenization, is followed by a discussion of the possibilities of applying the process to the production of engine fuel and lubricating oil. The possibilities offered by the process of reforming the molecular structure of petroleum hydrocarbons along directed lines to obtain products of the so-called paraffin or naphthene type are stressed.

Data are presented on the actual properties and performance characteristics of hydrogenated gasolines and lubricating oils.

From the test results the conclusion is drawn that hydrogenated lubricating oils made from common crudes are superior to the best natural lubricants now available, and that high-grade naphthenic gasolines and blending stocks can be produced from relatively low-grade gas oils.

It is further concluded that the ultimate results of the process will enable the engineer to design engines that are capable of operation at greater compressions, higher speeds, and higher temperatures.

Detonation Characteristics of Some Paraffin Hydrocarbons, W. G. Lovell, J. M. Campbell, and T. A. Boyd (Industrial and Engineering Chemistry (New York) 23 (1931), No. 1, pp. 26-29, fig. 1).—Experiments are reported in which the relative knock ratings of 27 paraffin hydrocarbons were determined in admixture with a commercial gasoline in an engine. These knock ratings are expressed on a common molecular basis using the antiknock effect of aniline as the standard of comparison.

On this basis definite relationships between molecular structure and a tendency to knock were found, which are summarized in the statement that in a homologous series the tendency to knock increases with the increasing length of the carbon chain, and in an isomeric series the tendency to knock usually decreases as the number of side chains is increased. The successive introduction of methyl groups into a carbon chain of given length also decreases the tendency to knock, and by substantially a constant increment per methyl group added.

Book Review

"Mechanical Training," by William Boss, J. Grant Dent, and H. B. White, all of the division of agricultural engineering, University of Minnesota, is described as "A book of instructions on the use of mechanical tools and the construction of exercises demonstrating fundamental principles in mechanical work, for use in school, colleges and for the practical mechanic." It is based on long experience on the part of all the authors in teaching mechanical subjects and on the lecture outlines, charts and other instructural material which they have developed. Subjects covered in its fifteen chapters are equipment, tool sharpening, soldering, cement work, rope work, belts, pulleys and laces, electric wiring, leather work, pipe fitting, cold metal work, babbitting, forge work, auto and tractor engine jobs, woodworking, and painting, wood finishing and glazing. Cloth bound, indexed, 9 x 6.25 x 0.75 inches, XI + 269 pages, 273 illustrations. Bruce Publishing Co. (St. Paul and Minneapolis) $3.00.

"Explosives in Agriculture" is a new booklet bringing together under one cover the combined knowledge of a group of authorities on the subject, and showing how explosives may most profitably be used in improving farm fields to facilitate the use of modern production machinery and methods. Separate chapters are devoted to major uses of explosives such as ditching, stumping, and rock and boulder blasting. Information is also given on a number of other farm uses; on the types, properties and action of explosives; on blasting accessories; and on safety, efficiency and economy in the handling of farm dynamite. Copies may be obtained on request to the publisher, the Institute of Makers of Explosives, 103 Park Ave., New York City.

"The Better Homes Manual," edited by Blanche Halbert, research director, Better Homes in America, Inc., is published cooperatively by that organization and the University of Chicago Press, which lists it as one of its home economics series. It is called "A concrete and concise handbook for everyone who is thinking of building or remodeling a home." While not of handbook size or makeup, it covers all phases of its subject with the same thoroughness. Extracts from the writings of prominent authorities, supplemented by the editor, are built into twenty-two chapters, and grouped under three general subheadings: (I) The Requirements for a Good Home, (II) Progress in Improving Housing Conditions, and (III) Organizations Engaged in Housing and Home-Improvement Work. There is a chapter on "Rural Homes" and others on such matters of engineering consideration as architecture, materials and utilities. Illustrated and indexed, with references listed at the end of each chapter. Cloth bound, 8½x6x1½ inches, XXII + 781 pages. University of Chicago Press, Chicago, Ill., and Baker and Taylor Company, New York City. $3.00.

AGRICULTURAL ENGINEERING

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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Raymond Olney, Editor

R. A. Palmer, Associate Editor

Meetings

WHEN the Land Reclamation Division of the American Society of Agricultural Engineers, in session during the annual meeting at Ames last June, decided to hold a winter meeting, it based its decision on the theory and experience that where even a few are brought together in the interest of land reclamation, the cause will surely benefit.

This proved true in the recent meeting at Chicago. While the attendance was small, as anticipated, the papers presented were of high quality. They concentrated the attention of all present on some important problems of land reclamation which need emphasis and increased study. The value of the meeting, from this standpoint, will be more fully realized as the papers are published. Reclamation and power and machinery men found a common interest in some of the papers. Valuable contacts were made. The earnest discussion and attention given to the papers reflected the inspiration felt by each man from the presence and activities of the group. Some of that inspiration must inevitably be carried back to work and workers in the field. There is no question about the meeting being worth while.

The same holds true for the Structures Division meeting.

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A notable number of individuals who are not professional agricultural engineers or specialists in this field were present. A dean of agriculture attended the sessions for three of the four days. Several agronomists and economists were on the program and took part in the discussions. Although there was no special farm management program, some farm managers were with us. There were also quite a few agricultural engineering students and recent graduates on hand. These are all favorable signs of the good will the Society and its work are gaining among the younger agricultural engineers, related agricultural sciences and administrators of agricultural education and research.

* * * * *

At every meeting of the Society or its technical divisions, the meetings question is brought up, either in session or between individuals. Some would have the winter meetings eliminated in favor of one big summer meeting; others feel that they get more out of the winter meetings than out of the annual meeting. Some want longer annual meetings so the divisions can have enough time for technical programs, with no overlapping, so they can take in everything; others want the programs shortened and concentrated so as to take less time from their work. Some see general sessions as indispensible to the solidarity of the profession; others minimize their value and importance. It is obvious that not everyone can be perfectly satisfied.

Eliminating personal viewpoints and preferences in favor of principles, from the standpoint of professional progress our meetings have only two functions. One is to promote understanding of the opportunities and problems which economic and social situations present to us as agricultural engineers, and, conversely, to interpret the economic and social significance of agricultural engineering progress. That is the purpose of general papers and addresses. The other is to promote understanding of technical principles and experiences involved in furthering the progress of engineering in agriculture. That is the purpose of technical sessions, small or large. Both functions are essential to the balanced development of our profession. Neither is more important than the other, although attention to the technical details requires more time.

That our annual and technical division meetings are accomplishing these ends to a continually greater degree is evident in the progress our profession has made and is making; in the feeling that each meeting is, in general, better than the last, though still far from perfection in the sense of satisfying every individual in all respects.

* * * * *

The Meetings Committee used good psychology, we believe, in planning the coming annual meeting program with general sessions in the morning, followed by technical division sessions in the afternoon.

If the speakers at the general sessions measure up to their job of interpreting the economic and social obligations and accomplishments of agricultural engineers, the insight and inspiration given will carry over to the afternoons, adding interest and direction to the deliberations and discussions of the technical programs.

* * * * *

Another part of the plan for the twenty-sixth annual meeting which warrants special commendation is the provision for joint sessions of the technical divisions.

Each technical division has technical problems in common with each other division. The Rural Electric Division has problems of applying electricity in structures, in reclamation and in the operation of farm machinery. The Power and Machinery Division, in addition to its community of interest with the Rural Electric Division, has problems concerning machines built in, operated in, or stored in structures; likewise problems on machinery to facilitate reclamation and to operate under reclamation conditions. Aside from the fact that they have indirectly related interests through power and machinery, and rural electrification, the Structures and Land Reclamation Divisions are directly related in reclamation structures and in drainage and water supply for structures.

No technical division of the American Society of Agricultural Engineers is sufficient unto itself. The mutual problems of these branches of the profession compel attention.

* * * * *

Referring again to the recent technical division meetings in Chicago, the committees of the Power and Machinery Division have learned how to make progress when they get together.

It is important to their plan that several committees meet at the same time, after a long day in the regular sessions. Then only those who are really interested will attend, and each individual can only be with the one committee in which he is most interested. The effect is to reduce irrelevant discussion to a minimum, which more than offsets the disadvantage of fatigue on the part of those present. The chairman can easily direct the discussion along predetermined lines, enabling the committee to

see clearly what it has accomplished and what remains to be done.

We look forward to notable results from the committees following this plan.

Opportunities for the Unemployed Engineer[1]

ONE of the most regrettable incidents of the present depression is the large number of highly trained and fully competent engineers that are unemployed. These men have spent years in honest service for some company and have only been let off when the finances and business prospects of that concern no longer warranted further employment.

The plight of such men in many cases is deserving of great sympathy from all fellow engineers. Realizing that they are without a job after long steady employment and further that no one else seems to want them, their psychological reactions are apt to be unfortunate. They see the future darkly. Their reserves, if they have any, are being used up and they feel absolutely helpless in the face of this economic disaster and of its effect on their future. Their plight has come about through no act of omission or commission on their own part. This attitude of hopelessness if allowed to persist can only lead to loss of confidence in oneself and to failure later when the depression has passed and opportunities for employment again prevail.

While these experiences test men's souls, this is no time for discouragement or despair. These unemployed engineers must face the competition of younger men when seeking new jobs. To be assured of employment, the older man must show that his training, experience, and technical knowledge are more valuable to the prospective employer than that of the younger man.

If the unemployed engineer would fully assure himself of his degree of superiority, let him take advantage of his idleness to prepare himself for his coming work. Much additional knowledge of the special elements of his particular branch of the profession has accumulated since his college days. Let him devote himself conscientiously for regular periods each day to the serious study of these new advances and to any necessary reviews of mathematics or other fundamentals that he may find necessary. Attendance at graduate courses in technical colleges is desirable if this can be managed.

If undertaken in all seriousness, this study will not only occupy his mind and tend to offset depressing thoughts, but will also reinspire him with a new confidence that he is becoming again master of his profession. He will in truth be better prepared for his next job and will have the advantage of past experience which the younger man lacks.

But better than even this renewed confidence in himself will be the by-products of such studies in the form of new ideas. Such serious perusal of the latest developments in his line and of the modern concepts of physics and chemistry, must develop new ideas and new ways of applying these ideas. When he takes up engineering employment again, he will not only adopt the latest methods but his new ideas will lead to improvements and developments of the art in many directions.

Another suggestion is for the engineer to devote a large portion of his time to a study of his special field in an attempt to discover and develop still better the products that he normally produces. If he can later approach an employer with improvements that at once indicate merit, his chances of employment will be improved and his reputation enhanced by this useful development work done in his otherwise idle period.

Let us therefore urge every unemployed engineer to devote himself seriously to studies of this nature and to thus capitalize his idleness. It will pay and pay magnificently in the end in renewed confidence and hope, but principally in new ideas.

[1]Mechanical Engineering, Vol. 53, No. 12 (December, 1931).

Agricultural Engineering Anthology

SOME piquant expressions of new and revived ideas, information and viewpoints.

* * * * *

After years of endeavoring to lift wheat prices by political agencies, marketing control, government buying, and similar means, not only in the United States but in many other wheat producing countries, a demonstration is afforded of what will really improve the situation; namely, adjustment of the supply to correspond with reasonable world demands. This adjustment will always be made eventually by farmers acting in their own self-interest, and is only delayed by interferences making it in their interest to keep on growing more wheat than is being consumed.—National City Bank Bulletin, December, 1931.

* * * * *

Certainly, when the West is casting about for a basis to gainfully employ its steadily mounting population and to provide jobs for those now employed in industries which are petering out because of exhaustion of nature's subsidy, it must set up a basis for agricultural expansion. From this foundation a superstructure of industrial expansion can then be built. The farm multiplies in compound ratio the opportunities for the professional man, the business man and the industrial worker and it alone provides a basis for confidence that we can continue to absorb our natural population increase and the swarming migration which in the future is coming to the West in search of a soft climate, better living conditions and opportunities for themselves and their children.

. . . . . .

The West must educate the public of this country to consider costs of supplying water under irrigation farming with the same matter-of-fact resignation that necessity for flood control, application of fertilizer, draining or terracing is accorded in the east and south.—John W. Haw, director of agriculture, Northern Pacific Railway Company, in an address at the Western States Governors' Conference, Portland, October, 1931.

* * * * *

Suppose that three or four years ago, when it became apparent that acreage in other parts of the world was increasing and the surplus of wheat also increasing, that those who were supposed to speak for the American farmer, instead of telling the farmer's customers that he was not going to continue to raise wheat for them at a price of $1.46½ a bushel, had told them that the American farmer was in the wheat export business to stay and that, if the southern hemisphere diverted large areas of their cattle grazing land to wheat, and if the Soviet Republic produced surplus wheat and dumped it on the world's market, they would have to share their market with the American farmer.

Suppose those speaking for the farmer and desiring to help him, instead of urging him to hold, had urged him to sell and such sales had forced the prices during the years 1927-1930, 20 cents below the level which did exist, what would have been the result? Increases in acreage would have been discouraged. There woud not have been the great wheat surplus raised. The lower prices during the years 1927, 1928, 1929 and 1930 would have increased consumption, with the result that at the present time, instead of being buried under a surplus of wheat, the present wheat supply and demand situation would probably have been reasonably well balanced.

Under the above circumstances, while during the four years above-mentioned the American farmer might have had to take 20 cents a bushel less for his wheat, yet, if that had occurred, he might and probably would be getting 50 cents more than he is at the present time with a much brighter outlook for the future.—"Helping the American Wheat Farmer," by Putnam D. McMillen, in the Minneapolis Journal.

A.S.A.E. and Related Activities

Technical Divisions Show Progress at Chicago Meetings

INTEREST, accommodations and committee accomplishments more than offset a somewhat decreased attendance at the winter meetings of the Power and Machinery, Structures and Land Reclamation Divisions of American Society of Agricultural Engineers held at the Stevens Hotel in Chicago, November 30 to December 3. The South and West Ballrooms on the third floor proved to be the most convenient, comfortable and quiet of any the Divisions have found in Chicago for these technical sessions. In spite of generally decreased allowances for travelling expense, total registration reached 168.

Prominent visitors present at one or more of the sessions either to take part in or to hear the program included H. C. M. Case, professor of farm management, University of Illinois; George D. Clyde, irrigation engineer, Utah State Agricultural College; W. H. Fairfield, superintendent, Dominion Experiment Station, Lethbridge, Alberta, Canada; C. L. Holmes, principal economist, U.S.D.A.; W. D. James, president, James Manufacturing Company; J. B. Kincer, chief of the division of agricultural meteorology, U. S. Weather Bureau; C. S. Noble, Nobleford, Alberta, Canada; W. G. Potter, drainage engineer, State of Illinois; H. L. Walster, dean of agriculture, North Dakota Agricultural College; and M. L. Wilson, professor of agricultural economics, Montana State College.

L. J. Fletcher, president of A.S.A.E., gave a brief inspirational message to each division at the opening of its meeting.

POWER AND MACHINERY

After a warming-up informal discussion period during the registration hour, the Power and Machinery Division, piloted by its chairman, G. W. McCuen, settled into its load of technical bone-grinding at 10 o'clock Monday morning.

"How many hours per year are most small farm engines run?" was the query of the day after E. G. McKibben presented the opening paper, "Factors Affecting the Economic Use of Tractor Engines at Part Loads." He called attention to load factors, load characteristics and other conditions which should influence a farmer's decision as to whether he can most economically power certain small machines about his farm with a small stationary gasoline engine which will have a low load factor, or by using his tractor motor, even though the load is too small for efficient operation. No one present had definite information on the subject but many believed that small farm engines are used about five hundred hours per year.

Dr. C. T. Holmes, chief of the U. S. D. A. division of farm management and costs, induced a compression knock by presenting figures indicating that the animal-power farmer may, when farm-product prices are low as at present, enjoy an actual cash advantage over the tractor farmer. His point was that the cash cost of low-cost production with tractor power is often higher than the cash cost of high-cost production with animal power—an important consideration when, and only when, prices are too low to keep even the low-cost producers out of the red. Agricultural engineering students of this problem did not leave off discussing it until they were sure that all present understood Dr. Holmes thoroughly on this point which might so easily be misinterpreted. They emphasized points he had mentioned, namely that (1) the advantage applies only to cash cost as distinguished from total cost, (2) it applies only in the case of farm prices too low to meet the low production costs of power farming, (3) it implies a low labor income and low standards of living accepted by the animal-power farmer for the sake of staying in business, (4) it prolongs the period of adjustment of production to demand and to low-cost methods.

Some agronomic aspects of agricultural engineering were brought to attention by John A. Slipher of the soils department at Ohio State University, in a paper on "Mechanical Manipulation of Soil as it Affects Structure." He pointed out that (1) soil is not a static, inert material; (2) the object of tillage is to promote granulation; (3) definite mathematical specifications for ideal soil profiles are needed; (4) a field measure for soil structure is needed; (5) a soil moisture calendar is needed; (6) the dust mulch is being supplanted by the clod mulch; and (7) tillage implements which lift the soil are growing in favor over those which stir the surface.

Monday noon members of the Committee on Power Take-Off treated themselves to a $1.50 dinner, celebrating the first birthday of their "brain-litter," the present "A.S.A.E. Standards and Recommended Practices for Agricultural Tractors and Machines." W. Leland Zink, chairman of the Committee, called for criticisms and objections to the standards and recommendations which might have been discovered in a year of their application. No one present knew of any serious points against them. The Committee decided to hold itself intact, subject to call on problems of application of the standards and recommendations.

Design papers featured the Monday afternoon program, with Louis Jacobi, engineer, Allis-Chalmers Manufacturing Co., presenting "Gear Loading Practice in Tractor Design," and C. G. A. Rosen, Diesel engineer, Caterpillar Tractor Company, covering "Diesel Engine Design for Tractor Service."

The fact that four committee round tables were scheduled simultaneously, and on Monday evening, sifted the attendance at each down to those who were most actively interested, with the result that effective work was done in each.

R. I. Shawl, chairman, and his Committee on Row-Crop Equipment devoted their time to discussing row-widths and the present tendency in some areas to reduce row widths. As some engineers present expressed the problem, farm machines cannot be made of rubber, to stretch to meet all variations of row widths. This being true, and row widths of the same and different crops varying greatly within small areas, row-crop equipment costs more to produce and is more limited in use than would otherwise be necessary. The Committee decided to get more data on row widths in various states preliminary to standardization efforts.

Three definite lines of study were decided upon by E. G. McKibben's Committee on Combine Development. I. D. Mayer of the agricultural engineering department of Purdue University is to study specifications, with particular reference to the small combine. F. P. Hanson, agricultural engineer, Caterpillar Tractor Company, will study methods of handling straw, and Walter H. Redit, junior agricultural engineer, U.S.D.A., is slated for work on the value of straw. Mr. McKibben stated during this meeting that to his knowledge an aggregate of twenty-nine crops have been reported successfully combined by at least one person.

E. A. Silver, chairman of the committee on Feed Mill Rating, had its problem well outlined and handed each of the members as a basis for discussion, a list of methods of rating hammer mills which had been suggested to the Committee. By a process of elimination the group decided on

"width of throat" as the best method so far suggested. They planned to give further study to this method, with a view to formulating a recommended practice; to data on desirable fineness of the different grains for various kinds of livestock; and to desirable peripheral speeds.

In a four-hour session the Committee on Fuels and Lubricants, R. B. Gray, chairman, considered many angles of the lubrication problem. Recognizing that a number of technical bodies have been studying lubrication for years, without making much progress, the Committee decided to study available data; to sift out that which is relevant to their problem; to determine the properties a lubricant must have to function as such under given conditions, and to write those properties into specifications which "gyp" oils will be unable to meet.

In the absence of W. M. Hurst, chairman of the Committee on Hay and Forage Crop Drying, R. B. Gray acted for him at a meeting held from 4 to 6 p.m. Tuesday. It was brought out that as a basis for further crop dehydration research with least duplication and lost motion there are needed a more definite index to quality of product, and more comparable test methods and data sheets. On motion of L. M. Kishlar, Ralston Purina Co., the Committee voted to pass on to Mr. Hurst a request for a symposium on hay and forage crop drying at the meeting next year.

Tuesday's morning and afternoon sessions were carried out smoothly and substantially as scheduled. Active and widespread interest was shown in the papers, which were largely reports of recent research on feed mill performance, machinery for sugar beet production, and grain for forage crop drying.

STRUCTURES

Attendance at the Structures Division meeting on December 1 and 2 was cut by a conflicting meeting of the President's Conference on Home Building which required the presence in Washington of some of the Division's old stand-bys. Those present also regretted to learn that J. L. Strahan, active member and former chairman of the Division, has been confined to a hospital for some time and was therefore unable to be present or to submit a report for the Committee on Dairy Barn Standards.

The meeting was highly successful, however, from the standpoint of interest, value of papers presented, and definite progress reported and recommendations made by certain committees. Particularly the Committee on Standardization of Hog House Plans, I. D. Wood, chairman; the Committee on Standardization of Poultry Houses Plans, Henry Giese, chairman; and the Committee on Standardization of Dairy Barn Plans reported progress sufficient to bring real achievement within sight. The Division encouraged them to continue their work aggressively.

E. G. Lantz, chairman of the Committee on Fire Prevention and Protection, presented its report, which was supplemented by a report of the National Fire Protection Association's agricultural committee. The personnel of this latter committee includes six A.S.A.E. members. Copies of its report are to be sent to Structure's Division men in the near future.

S. H. McCrory, chief of the Bureau of Agricultural Engineering, reported on the program and accomplishments thus far of the President's Conference on Home Building.

A report of the Committee on Farm House Standards and Designs sent in by D. G. Carter, was read.

E. D. Anderson, agricultural engineer, Iowa State College, presented the one technical paper of the first day's session, his subject being "Tests on Built-Up Rafters."

Division Chairman W. C. Harrington turned over the task of presiding for the second day to Henry Giese, vice-chairman of the Division.

Robert C. Ferris of Hunt, Helm and Ferris Co., gave a short extemporaneous account of the company's experiences with forced ventilation.

"Recent Developments in Zinc Coating of Steel for Structural Uses," by Geo. C. Bartells, field representative, American Zinc Institute, and "Design of Gambrel Roof Barns with Respect to Wind Loads," by F. C. Fenton, professor of agricultural engineering at Kansas State College, were presented by the authors and illustrated with lantern slides. Papers sent in by authors who were unable to be present, and which were read and discussed, were "The Structural Application of Lumber to Farm Buildings," by Frank P. Cartwright, chief engineer, National Lumber Manufacturers Association; "Farm House Planning," by W. A. Foster, agricultural engineer, University of Illinois; and "The Preparation and Distribution of Plans for Farm Buildings," by W. D. Brinckloe, architect.

Mr. Brinckloe's paper suggesting a nation-wide, non-profit agricultural plan service bureau, together with a letter from Mr. Strahan suggesting a somewhat different type of farm plan service, stimulated much discussion, but as neither of the men were present no action was taken.

LAND RECLAMATION

Small in numbers but strong in program and far-reaching in influence was the meeting December 2 and 3 of the Land Reclamation Division. James A. King, vice-chairman of the Division, gave a short opening address on a "Proposed Standard to Measure the Wisdom of Reclamation Projects." He said that since profit is the measuring stick of the public mind and in especially current use at this time it should also be applied as the measure of reclamation wisdom and be made the keynote of the two-day meeting.

A paper by Mr. McCrory on the "Rehabilitation of Reclamation Projects Now in Difficulty" pointed to over-optimism, speculation, poor engineering and legal technicalities as the bases of the difficulties.

Geo. D. Clyde, associate professor of irrigation and drainage, Utah Agricultural College, in a paper on "Methods of Supplementing the Water Shortage on Irrigation Projects," described a device and method for predicting accurately before spring planting time the amount of water available from the watersheds of irrigation projects. This enables farmers to adjust their planting to the available water supply.

"Pumping for Drainage in the Upper Mississippi Valley," by J. G. Sutton, agricultural engineer, U.S.D.A., was the one paper on the program dealing with the removal of surplus water. It was followed in the afternoon by a symposium on "The Drought Menace." Contributions were "Probable Frequency of Such Nation-Wide Droughts as that of 1930 and 1931," by Joseph B. Kincer, in charge of agricultural meteorology, U. S. Weather Bureau; "Frequency of Disastrous Regional Droughts in Semi-Arid Regions," by M. L. Wilson, professor of agricultural economics, University of Montana; and "Frequency of Disastrous Regional Droughts in the Pacific Coast Region," by Chas. H. Lee, consulting hydraulic engineer. Mr. Clyde presented this paper for and in the absence of Mr. Lee. On the first day the paper by W. A. Hutchins, irrigation economist, U.S.D.A., dealing with "Indirect Benefits of Reclamation Projects," was also read in his absence. A report from Dan Scoates, chairman of a committee to study the frequency of disastrous regional droughts, pleaded for more time in which to study this intricate problem.

Each half of the second day was given to a symposium. In the morning the subject was "Methods of Protecting Crops Against Drought in Humid and Semi-Arid Regions." Paul H. Stewart, extension agronomist, University of Nebraska; R. E. Dickson, Texas Agricultural Experiment Station; I. D. Wood, state extension agricultural engineer, University of Nebraska; and J. H. Neal, agricultural engineer, University of Minnesota, were the contributors. The methods discussed were irrigation as stand-by crop insurance, terraces to conserve surface run-off, planting of cultivated row crops on contour lines, and underdrainage of clay soils and subsoils.

"Latest Aspects of the Control of Soil Erosion by Engineering Processes" was the general subject for the afternoon. L. A. Jones summarized a contribution by R. A. Norton on a "Soil Sampling Device for Measuring Soil Losses from Terraced Areas." "Operation of Farm Machinery Over

Terraced Land" was covered by C. E. Ramser, senior drainage engineer, U.S.D.A. E. W. Lehmann, head of the department of farm mechanics, University of Illinois, gave a detailed report of the erosion control extension work being done in that state.

Vice-chairman King read the contribution from A. K. Short, conservation and terracing agent, Federal Land Bank of Houston, on "The Use of County Equipment for Erosion Control as Permitted by Texas and Oklahoma State Laws." After this last paper the meeting was thrown open for discussion.

ANNUAL MEETING PLANS

A session of the Meetings Committee gave shape to plans for the 26th annual meeting to be held at Columbus, Ohio, in June. Monday, June 20, is reserved entirely for the College Division, which plans to give time and attention to both research and extension. Morning sessions the following three days will be for the Society as a whole, with contributions from each of the technical divisions, and a symposium on "An Engineering Program for Agriculture," and several outside speakers. Negotiations on these arrangements are already under way. Technical division meetings are scheduled for the afternoons. Each afternoon will be split into two separate and distinct periods of approximately two hours each and not more than two divisions are to be in session concurrently. During one of these periods papers of interest to at least two divisions are to be presented. It is believed by the Meetings Committee that this arrangement will allow each Division enough time and still keep undesirable overlapping of programs to a minimum.

At a meeting of the Council it definitely accepted for the Society an invitation from Purdue University to hold the annual meeting of the Society there in 1933.

Necrology

WILLIAM LOUDEN, pioneer barn equipment inventor and manufacturer, and honorary member of A.S.A.E. since 1921, passed away quietly at his home in Fairfield, Iowa, on November 5, after an illness of about two weeks.

Born in Pennsylvania, October 16, 1841, he was brought to Iowa by his parents the following summer. There they settled on a farm seven miles southeast of Fairfield. After receiving his education in the country schools and Axline University he returned to the farm and in his father's shop invented and built the first hay carrier in 1867. The following year he married Mary Jane Pattison, and in 1869 moved to Fairfield, established the Louden Machinery Company and built a small factory for the manufacture of hay tools. In spite of numerous difficulties the business was making good progress when the panic of 1873 set it back to its starting point. By staying with it, inventing new equipment, improving the old, taking his brother into the business, developing a barn planning service and taking other progressive steps he re-built and expanded the business to its present proportions.

In 1914 he became a member of A.S.A.E., was active in its farm buildings work and later served one three-year term on the Council of the Society. In 1921 it elected him an honorary member in recognition of his leadership in the development of barn equipment. He was active in the management of the company he founded, and in several other companies, up to the time of his fatal illness, which followed shortly his ninetieth birthday. As a public spirited citizen he was also a member of many civic organizations.

He is survived by his wife, three of his four children and his brother, R. B. Louden.

A Correction

IN THE article "The Relation of the Agricultural Engineer to the Farm Equipment Industry," by L. J. Fletcher, which appeared in our November issue on page 406, the third sentence in the opening paragraph is misprinted. It should read "Measured in terms of the increase of productive efficiency of the individual farmer, this period, representing the introduction of mechanical farm power, will undoubtedly be recorded in history as including one of the greatest advancements which the industry of agriculture has ever experienced."

Personals of ASAE Members

Lyman H. Hammond has resigned as rural electrification specialist for the Westinghouse Electric and Manufacturing Company to associate himself with John Ross McKay in the McKay-Hammond Rural Electric Engineering Company. The new company, which is located at Caledonia, New York, will distribute Westinghouse electrical farm equipment in that state.

E. R. Raney was appointed July 1 assistant state supervisor of vocational rehabilitation of the Texas State Board for Vocational Education. His new address is Chamber of Commerce Building, Dallas, Texas. He was formerly field agricultural engineer of the Portland Cement Association.

H. B. White, agricultural engineer, University of Minnesota, is joint author with L. W. Neubauer of Minnesota Agricultural Extension Special Bulletin No. 142, entitled "Farmhouses."

ASAE Meetings

Pacific Coast Section—at Sacramento, California, Friday, January 22, 1932.

Southern Section — at Birmingham, Alabama, February 3, 4 and 5, 1932.

Twenty-Sixth Annual Meeting — at Columbus, Ohio, Monday, June 20, to Thursday, June 23, 1932, inclusive.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the November issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Russell H. Anderson, curator of agriculture and forestry, Museum of Science & Industry, Chicago—2151 Maple Road, Homewood, Ill.

Russell E. Backstrom, insulation specialist, National Committee on Wood Utilization — 2707 Adams Mill Road, Apt. 200, Washington, D.C.

Edgar Lee Barger, instructor in agricultural engineering, Kansas State College, Manhattan, Kans.

Clark T. Cheney, graduate assistant in agricultural engineering, I. S. C., 1013 Ninth St., Ames, Ia.

Joseph H. Lane, manager eastern sales, Long-Bell Lumber Sales Corp — 913 R. A. Long Bldg., Kansas City, Mo.

Joseph MacKie, field research; farm buildings, Weyerhaeuser Forest Products — c/o Weyerhaeuser Forest Products, 808 Merchants Bank Building, St. Paul, Minn.

Lawrence A. Nicholson, associate editor "The Country Gentleman" — Curtis Publishing Company, Philadelphia, Pa.

Walter H. Redit, junior agricultural engineer, U.S.D.A. Bureau of Agricultural Engineering, 217 Raymer Blvd., Toledo, O.

M. W. Ross, branch manager, International Harvester Company of America—Des Moines, Ia.

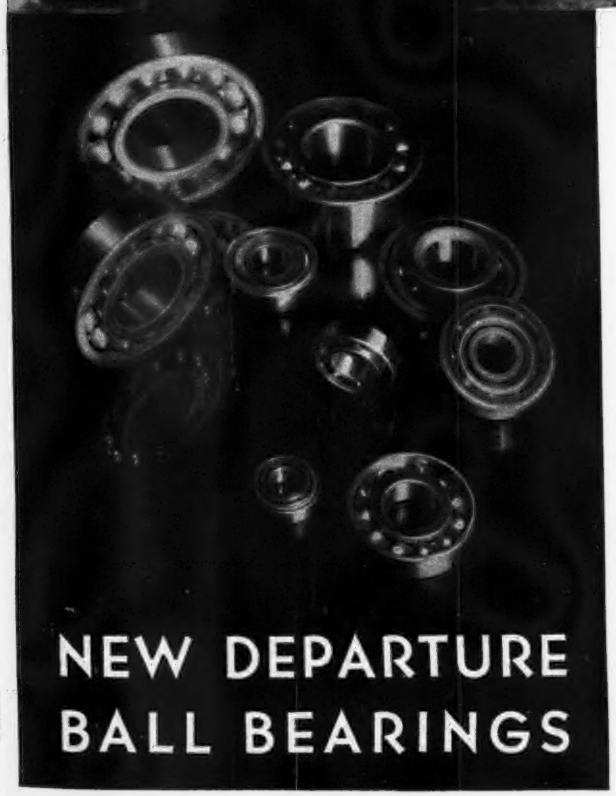
Lenore E. Sater, assistant professor, Household Equipment Dept., Iowa State College — 414 Lynn, Ames, Ia.

O. J. Trenary, instructor in agricultural engineering, University of Nebraska—240 N. 16th St., Lincoln, Nebr.

Byron T. Virtue, research fellow, Iowa State College — Agricultural Engineering Department, Station A, Ames, Ia.

Transfer of Grade

B. E. Gaylord, farm building engineer, Weyerhaeuser Forest Products — 1108 Merchants Bank Building, St. Paul, Minn. (Assoc. to Member)



NEW DEPARTURE
BALL BEARINGS

The use of New Departures
is growing
growing
growing!

As farm machines are built better . . . have longer life . . . and finer performance, more New Departures are used at all vital moving points. They naturally go hand in hand. Never has a bearing taken such a hold on industry . . . and never have more of them been used. Cletrac tractors are utilizing the superlative values of New Departure Ball Bearings at every possible position. This indicates in a positive way the high-grade product that Cletrac is delivering. The New Departure Mfg. Company, Bristol, Conn. Branches at Detroit, Chicago and San Francisco.

1810

Always look for the **Red Brand (top wire)**

Fence Is Farm Equipment

[and just as important as a plow!]

FARMERS should use their fence to make more money, just as they do their other labor-saving, cost-reducing equipment. If their farms are well fenced, they can rotate their crops and stock, "hog down" corn, save shattered grain, "clean out" weeds with sheep, reduce labor costs and reap extra profits that more than pay for the cost of the fence. Thousands of farmers have done just that. The Keystone "Farm Planning" book tells how farmers in 16 states made more than market prices for their work. Write for it. RED BRAND fence, at new low prices, costs less per rod per year than ever before. It's the biggest fence VALUE for the money today.

Every Test Proves **RED BRAND** Best

Here's what Nationally known authorities say: "Definitely superior to any competing fence," says the BURGESS LABORATORIES' report of the Official Weather Test on the Gulf of Mexico, where almost a lifetime test was completed in 4½ years. When 45 different makes and sizes of fence were purchased on the open market and exposed to the damp, salt sea air and smoky atmosphere, patented RED BRAND "Galvannealed" fence was still good for several years more service while all others were either badly rusted, corroded or entirely worthless.

"Microscopic photographs reveal a much greater amount of zinc coating on RED BRAND 'Galvannealed' fence, when compared with galvanized makes." — SHAW LABORATORIES, San Francisco, Calif.

In these as well as laboratory tests, stripping tests and in actual farm use, RED BRAND always proves its superiority. Because this patented "Galvannealed" fence has much more zinc protection, plus copper-bearing steel in the wire. IT CANNOT HELP BUT RESIST RUST YEARS LONGER.

Write for details of tests and a copy of our home library book on "Farm Planning." They'll enable you to answer fencing questions with authentic facts.

Keystone Steel & Wire Company

9455 Industrial St. **Peoria, Illinois**

A *program* FOR AGRICULTURE TODAY

A MESSAGE TO AGRICULTURAL ENGINEERS

Seventh of a Series

EVEN in these trying days of agriculture, many farmers are recognizing the importance of explosives as an aid in making their farms profitable.

These farmers realize that *production at minimum cost per acre* is the best way to make the farm pay. You can't control *commodity prices* but with explosives you can often effect lower *production costs* by: (1) eliminating waste space in present fields; (2) utilizing the best soils on the farm; and (3) shaping fields for more efficient operation.

Summarized, this is how explosives can help:

1. Eliminating waste space.

Stumps, boulders, and other obstructions hinder farming operations with modern machinery. (It is estimated that 20% of farm acreage is waste space; explosives can bring in much of this waste acreage and thus increase operating efficiency.

Modern *farm* Explosives

HERCOTOL
(for stump and boulder blasting)

In our sincere belief, HERCOTOL *is the greatest farm explosive value on the market because it costs less per cartridge than the explosives it replaces.* HERCOTOL *is especially suitable for stump and boulder blasting, but it can be used for any kind of agricultural blasting excepting propagated ditch blasting. There are about 175 cartridges* per 50 lb. of* HERCOTOL.

HERCULES DITCHING DYNAMITE
(for ditch blasting)

HERCULES DITCHING DYNAMITE *was made expressly for ditch construction under wet conditions where the propagated method of blasting is the best and most economical method of ditching. Every effort was made to embody the advantages desired in an explosive for this purpose.* HERCULES DITCHING DYNAMITE *resists water well; it is low freezing; its quality is uniform; and its action spreads the earth back, allowing cultivation close to the ditch. There are about 108 cartridges* per 50 lb. case.*

*(1¼ in. x 8 in. cartridges)

2. Utilizing best soils.

Sub-marginal land in farmed areas should be abandoned for adjacent rich bottom lands which can be drained and made available by cleaning old ditches and blasting new ones with dynamite.

3. Shaping fields.

Fields regular in shape are better adapted to modern machinery and allow maximum cultivation efficiency; explosives can be used economically in this work.

We have developed "Hercules Ditching Dynamite" and "Hercotol" specifically for farm blasting. We shall be glad to consult with you regarding their application to modern farming.

F-19

HERCULES POWDER COMPANY
INCORPORATED
Wilmington, Delaware

ALLENTOWN, PA. - - - BIRMINGHAM - - - BUFFALO - - - CHICAGO - - - DENVER - - - DULUTH - - - HAZLETON, PA.
HUNTINGTON, W. VA. - - - - - JOPLIN, MO. - - - - - LOS ANGELES - - - - - NEW YORK CITY - - - - - PITTSBURG, KAN.
PITTSBURGH, PA. - - - ST. LOUIS - - - SALT LAKE CITY - - - SAN FRANCISCO - - - WILKES-BARRE - - - WILMINGTON, DEL.

Announcing the New, Completely-Equipped

McCormick-Deering Hammer Mill No. 1

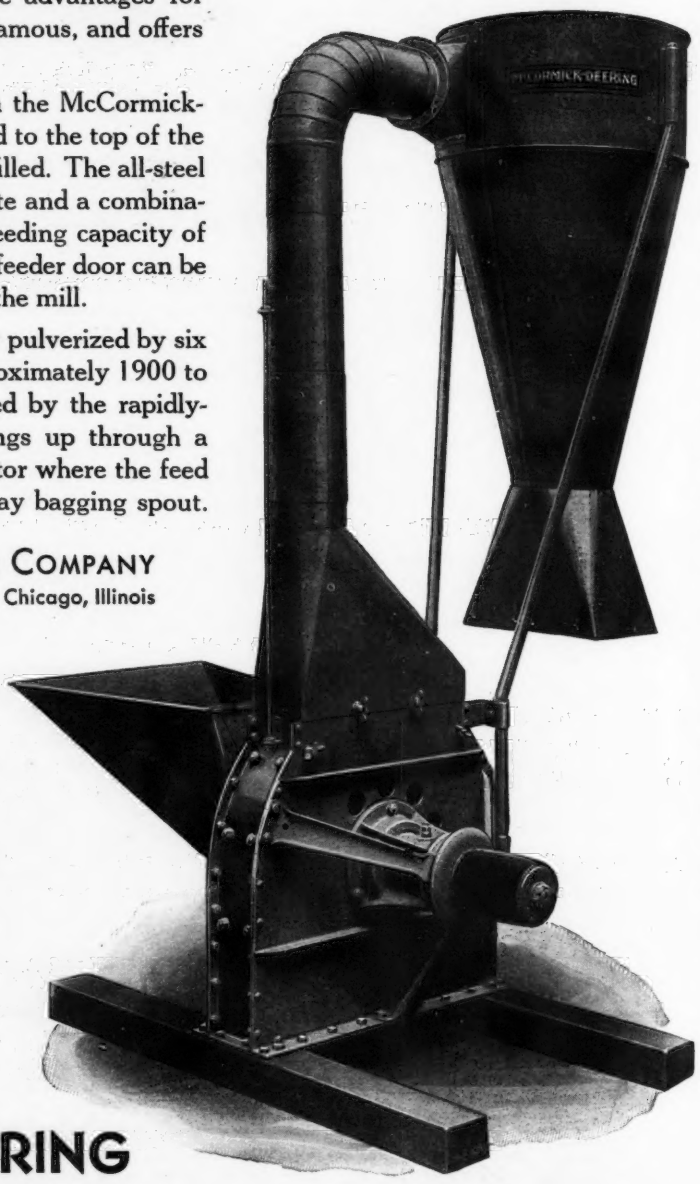
with Cyclone Dust Collector and 2-Way Bagger

HERE is a new McCormick-Deering product which meets a distinct need among farmers and live-stock feeders. It offers all the advantages for which mills of this type have become famous, and offers them at a new low price.

The convenient, full-size hopper in the McCormick-Deering is 26⅝ inches from the ground to the top of the bagger, making it easy to fill and keep filled. The all-steel hopper is built with a gravity feed chute and a combination feeder door which regulates the feeding capacity of the mill. When grinding ear corn, the feeder door can be raised, which permits the ears to enter the mill.

The grain or roughage is efficiently pulverized by six heavy steel hammers revolving at approximately 1900 to 2000 r.p.m. The wind blast produced by the rapidly-revolving hammers forces the grindings up through a screen and into the cyclone dust collector where the feed drops into bags attached to the two-way bagging spout.

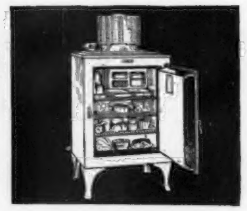
INTERNATIONAL HARVESTER COMPANY
606 So. Michigan Ave. OF AMERICA (INCORPORATED) Chicago, Illinois

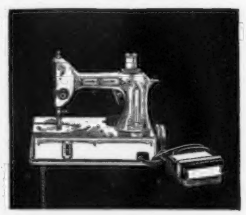


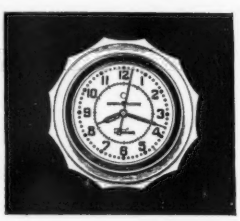
A Mill of Superior Design
with many advanced features

The McCormick-Deering Hammer Mill No. 1 has been tested on hundreds of farms in various sections of the country and under all grinding conditions. It grinds shelled corn, ear corn, wheat, oats, barley, beans, peas, rye, and various roughages, providing a palatable, easily digested live stock feed at minimum cost. All moving parts, including the flywheel, are assembled on a shaft mounted on two large ball bearings. These bearings run in a bath of oil and are fully enclosed and protected from dust, dirt, and water, assuring long life and minimum friction.

McCORMICK-DEERING







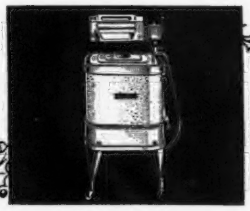
For Christmas

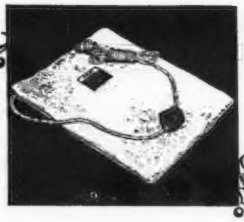
ELECTRICAL GIFTS

WHAT better Christmas gift than provision for comfort—and health—and convenience! Home electric appliances—builders of happiness—servants that save time and money. A G-E refrigerator, for instance, with its unvarying cold, its generous capacity, and its mighty saving of food. Or a G-E Hotpoint range, the perfect cook—or a G-E washer and ironer, that lighten the labor of washday—or a vacuum cleaner or sewing machine, tireless and efficient helpers. And a G-E radio, with its music and mirth and farming information. A G-E clock, perhaps, to time the daily duties, a G-E Sunlamp for its healthful, ultra-violet rays, or a G-E Hotpoint heating pad with its comforting warmth. There's a G-E appliance for every purse and every purpose. And all may be purchased on easy terms.

Send for our new booklet, "Electric Helpers for the Farm." Address Room 315, Building 6, General Electric Company, Schenectady, N. Y.

JOIN US IN THE GENERAL ELECTRIC FARM PROGRAM
FROM WGY, SCHENECTADY, EVERY FRIDAY EVENING
AT 8:30 O'CLOCK, EASTERN STANDARD TIME

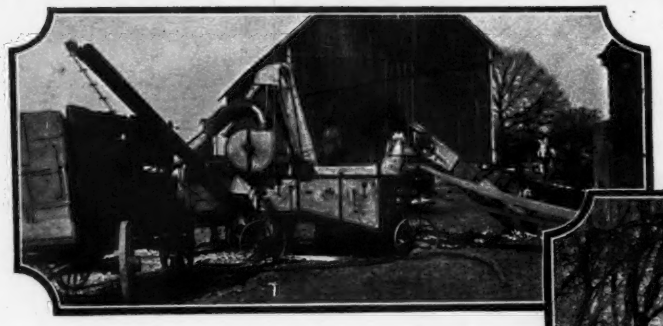




GENERAL ELECTRIC

95-911

They Meet the Farmer Demand



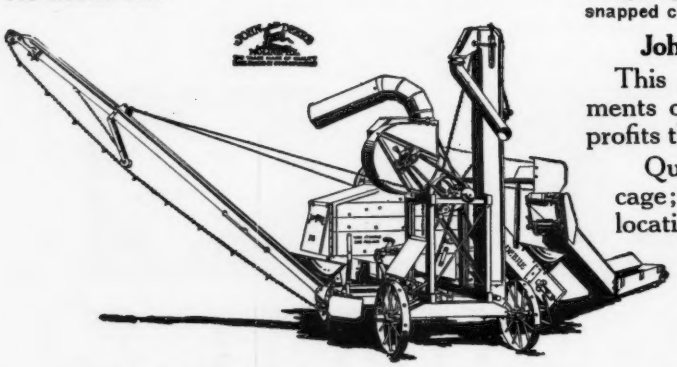
John Deere No. 9 Cylinder Shellers at work on Illinois farms. Note the compact, all steel construction

The John Deere No. 9 Cylinder Sheller has a shelling capacity of from 250 to 500 bushels of corn per hour. Power required---20 hp. engine

John Deere Cylinder Shellers Match Every Shelling Need

THE better performance of John Deere Cylinder Shellers puts them in big demand throughout the corn belt. You will like their fast, clean shelling and appreciate the saving of labor expense due to the small crew required to operate them.

John Deere Cylinder Shellers are made in two sizes: the No. 9 for the large corn grower or job shellerman, and the No. 5 for the farmer who wants a small power sheller for home use.



The John Deere No. 5 Cylinder Sheller regularly equipped with swivel cob stacker, wagon box elevator and stationary feeder

John Deere No. 9 Cylinder Sheller

This big-capacity, all-steel sheller successfully handles present day corn. Adjustable shelling cage; swinging feeder; rust-resisting, galvanized, copper-alloy sheet steel construction; two vibrating shoes and cleaning fans; heavy-babbitted bearings; three driving positions; pressure lubrication and extreme simplicity and durability are outstanding No. 9 qualities.

Capacity: husked corn—250 to 500 bushels per hour; snapped corn—75 to 125 bushels per hour.

John Deere No. 5 Cylinder Sheller

This popular sheller meets the requirements of the farmer who wants to get the profits that result from shelling his own corn.

Quality features are: adjustable shelling cage; greater cleaning area and proper location of cleaning shoes; efficient shuck separator with powerful suction fan; pressure lubrication; four driving positions; extreme simplicity.

Capacity: 100 to 150 bushels husked corn per hour; 25 to 50 bushels snapped corn per hour.

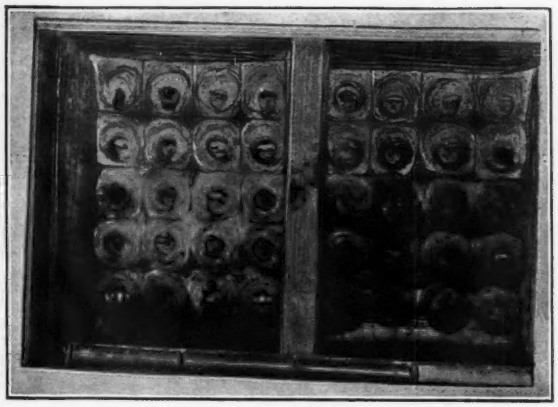
See these money-making John Deere Cylinder Shellers at your John Deere dealer's store. Write for free descriptive folders.

JOHN DEERE

MOLINE, ILL.

THE TRADE MARK OF QUALITY MADE FAMOUS BY GOOD IMPLEMENTS

. . LOW FREEZING . .



Open View of Refrigeration Chamber

The modern development of Atlas Explosives most effectively immunizes dynamites against freezing. The freezing test has become almost unnecessary because experience has proven that all Atlas Dynamites are practically non-freezing.

Atlas methods of control to secure low freezing properties begin with the selection of the proper ingredients including the use of Special Low Freezing Nitroglycerine mixtures. Absorbent materials are carefully dried to exclude moisture. Methods of low freezing control end with scientific refrigerating tests that leave nothing to chance.

The ability of Farmex Explosives to resist cold temperatures assures the user of the highest degree of effectiveness, and dependable results regardless of any low temperature conditions under which the work is ordinarily being done.

This advertisement is one of a series devoted to various types of control exercised in the making of Atlas Explosives.

ATLAS POWDER COMPANY
WILMINGTON, DELAWARE

ATLAS FARMEX EXPLOSIVES

STUMPING » » BOULDER « « DITCHING

Subscription Order

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AGRICULTURAL ENGINEERING

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
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Date.....

Enclosed you will find a remittance of $.....in payment of one year's subscription to AGRICULTURAL ENGINEERING, the monthly journal of your Society, to begin with the.....issue and to be sent to the address below.

[**Subscription terms: $3.00 a year, payable in advance; Canadian and foreign subscriptions, $4.00 a year.**]

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Check below the branches of agricultural engineering in which especially interested

.....Power and Machinery.....Rural Electrification.....Buildings and Other Structures

.....Agricultural Manufactures.....Drainage.....Terracing.....Irrigation.....Land Clearing

.....

Galvanized Sheets Protect

a Symbol of Superiority

Heavy-Coated Galvanized Sheets

"Seal of Quality" Galvanized Sheets, made in the popular corrugated and V-crimped styles, carry the Zinc Institute standard coating — **2 ounces per square foot** — proved by surveys and tests to be the best for rural building purposes.

Such sheets are strong — attractive — economical — fireproof — lightning proof (when properly grounded) — and above all, **durable.** Their heavy protective coating is the best possible safeguard against rust and upkeep expense. Length of life is at least twice that of regular commercial galvanized sheets.

Always use "Seal of Quality" Galvanized Sheets to reduce roofing expense. A valuable booklet, "Directions for Laying Galvanized Roofing" will be sent free.

American Zinc Institute
Incorporated
60 E. 42nd St. New York, N. Y.

USE THIS COUPON

American Zinc Institute
60 E. 42nd St., New York, N. Y.

Please send me "Directions for Laying Galvanized Roofing."

Name_____

Address_____

Professional Directory

Wendell P. Miller and Associates
Consulting Engineers
and specialists in the development of airports, parks, estates, cemeteries, and recreational grounds, including golf courses, polo fields, athletic fields, race tracks, and tennis courts.
105 West Monroe Street, Chicago Phone State 4507

KURT GRUNWALD
Consulting Agricultural Engineer
Investigations of crop adaptability in arid and humid regions, potential sugar beet and cane production, and irrigation and drainage problems. Appraisals of land. Supervision of farms and ranches. Selection of livestock breeds.
Patchogue, Long Island, N. Y. Phone Patchogue 134

For Consulting Engineers

AGRICULTURAL engineers, who are doing consulting work or who wish to build up a consulting practice, will derive much benefit from carrying an advertisement in this Directory of Professional Agricultural Engineers. There is an increasing demand for the services of consulting engineers in the agricultural and allied industries. Those who seek to render service in this field will find that a card in this directory will help to establish their name and service in the profession.

Rates for professional cards like the above—size 1 by 3½ inches—are as follows:

To ASAE. members: $2.00 per insertion for not less than 12 consecutive insertions; $3.00 per insertion for less than 12 consecutive insertions.

To non-members: $4.00 per insertion for not less than 12 consecutive insertions; $6.00 per insertion for less than 12 consecutive insertions.

ASAE

Wear The Emblem

Every agricultural engineer who is a member of the American Society of Agricultural Engineers, should wear the official emblem of the Society. It identifies him with the national organization representing his chosen profession; it helps to give him standing in his profession. The price of the official A.S.A.E. emblem with blue background is $2.50, equipped with screw post and button back; or $3.00 equipped with jeweler's safety cach pin. Red background emblems with safety catch pin fastener (worn by Junior, Affiliate and Student members) are available at $1.50.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS
Saint Joseph, Michigan

Modern Lubrication Methods are as Essential as Power Machinery....

To Successful, Profitable Farm Operations

It is almost too obvious to state that successful farming depends on power machinery.

Tractors, combines, individual threshers, shredders, grinders, and scores of other machines are now common to all successful farmers.

Yet with this greater array of power machinery, think of the loss of efficiency and the additional expenses caused by a failure to adopt modern lubricating methods.

In industrial plants, maintenance engineers have discovered the necessity of correct lubrication. They have discovered three fundamental facts which apply just as forcefully to farm production. These are:

1 Correct lubrication . . . Alemite Specialized Lubrication . . . will reduce machinery repair bills 80%.

2 Correct lubrication . . . Alemite Specialized Lubrication . . . will save 70% of the time required for lubricating.

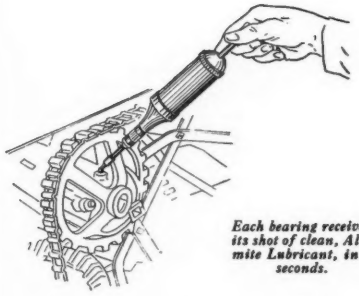
3 Correct lubrication . . . Alemite Specialized Lubrication . . . will reduce the cost of lubrication 50%.

The farmer brings his handy filler tank for new supply.

The drum of Alemite Lubricant, equipped with a special pump, remains in the dealer's store.

From the filler tank or bucket he fills his Alemite gun.

Or, he does the same with this filler bucket.



Each bearing receives its shot of clean, Alemite Lubricant, in 2 seconds.

Alemite Specialized Lubrication comprises first, the Alemite High Pressure System and Alemite Compressors. Second, Alemite Special Lubricants, manufactured under strict and scientific formulas so as to give 100% efficiency to the Alemite System.

That it is efficient is proved by its adoption as standard equipment by over 100 manufacturers of farm machinery.

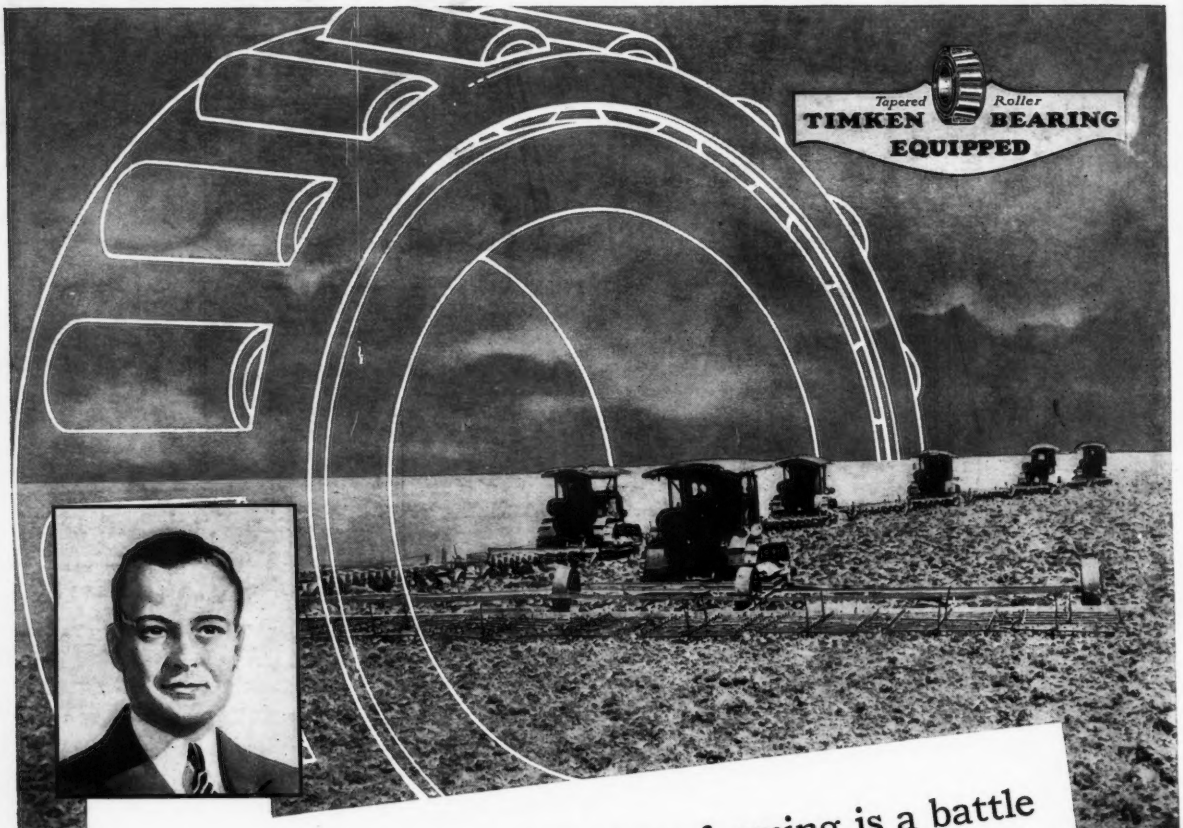
Alemite brings to the farm the efficiency of the factory.

We have prepared for students of farm efficiency material well worthy of your consideration and study . . . material you will want to keep for continuous reference.

A line from you will bring it.

ALEMITE

ALEMITE CORPORATION
(Division of Stewart-Warner)
2656 North Crawford Avenue
CHICAGO, ILLINOIS



HICKMAN PRICE says: "Modern farming is a battle of equipment. More and more, agriculture depends upon machinery. The elimination of friction in its use is of the utmost importance. There is no better way to procure it than through the use of Timken Tapered Roller Bearings."

Mr. Price owns and operates a 30,000 acre farm, thoroughly mechanized and Timkenized. He is popularly known as the "Wheat King of the Texas Panhandle."

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**